SCIENTIFIC REPORTS

OF THE

Agricultural Research Institute, Pusa

(Including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau)

1924-25

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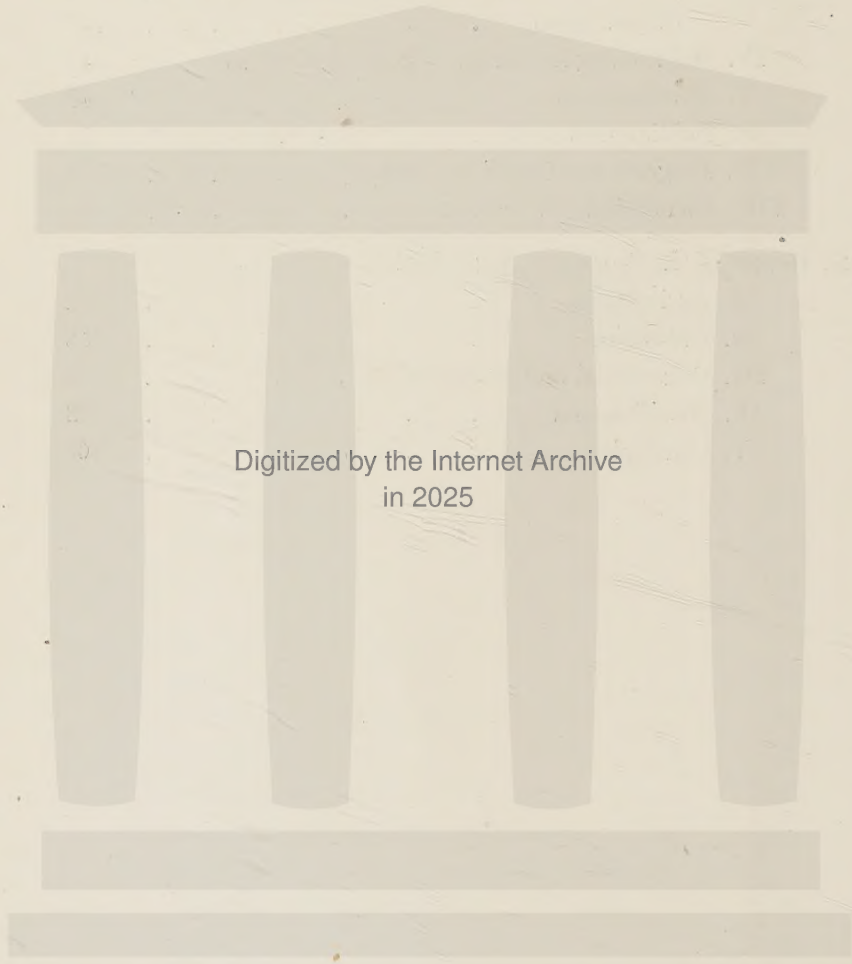

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Scientific Reports of the Agricultural Research Institute, Pusa

(*Including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau.*)

1924-25

REPORT OF THE DIRECTOR.

(D. Clouston, C.I.E., M.A., D.Sc.; and G. S. Henderson, N.D.A., N.D.D.)

I. Charge and Staff.

Charge. Dr. W. H. Harrison officiated as Agricultural Adviser to the Government of India, and Director, Agricultural Research Institute, Pusa, up to 24th October, 1924, when Dr. D. Clouston, C.I.E., returned from leave. Dr. Clouston has been confirmed in the post with effect from 10th September, 1924, the date from which Mr. S. Milligan has been permitted to resign his appointment in the Indian Agricultural Service.

The post of Joint Director was held by Dr. W. McRae until 24th October, 1924, when the permanent incumbent, Dr. W. H. Harrison, reverted to duty. From March 6th, 1925, the date on which Dr. Harrison took leave for eight months, Mr. G. S. Henderson has been officiating in the post.

Staff. Directly on return from leave on 27th October, 1924, Mr. A. Howard, C.I.E., and Mrs. G. L. C. Howard, Imperial Economic Botanists, were deputed on foreign service for employment as Director and Physiological Botanist, respectively, of the Institute of Plant Industry, Indore, Mr. Howard

to act also as Agricultural Adviser to States in Central India. Maulvi Abdur Rahman Khan remained in charge of the Botanical Section until 25th August, 1924, when Dr. F. J. F. Shaw was recalled from leave to officiate as Imperial Economic Botanist.

Mr. J. N. Mukerji officiated as Imperial Agricultural Chemist until relieved by Dr. W. H. Harrison on 24th October, 1924. On Dr. Harrison's proceeding on leave on 6th March, 1925, the charge was taken over by Dr. J. Sen, Supernumerary Agricultural Chemist, who had reverted on 1st March, 1925, from the officiating appointment of Forest Chemist, Dehra Dun.

On expiry of his deputation to Bihar and Orissa, Mr. G. S. Henderson resumed charge of the post of Imperial Agriculturist from Mr. M. Wynne Sayer on 22nd October, 1924.

Dr. W. McRae having proceeded on leave for seven months from 23rd April, 1925, Mr. M. Mitra was placed in charge of the current duties of the office of Imperial Mycologist.

Mr. T. Bainbrigge Fletcher, Imperial Entomologist, is on leave for 18 months from 28th April, 1925, and Mr. M. Afzal Husain has been officiating for him.

Mr. P. V. Isaac, Second Entomologist (Dipterist), was on leave for one month and 24 days from 30th October, 1924.

II. Research.

The main aim of the research work carried on at the Institute is to establish principles which can be applied to local problems by Provincial Departments. The more important work of the year under report is summarized below :—

Botanical Section. In addition to Pusa 4 and Pusa 12 wheats, which have now an established position more especially in the agriculture of Northern India, the Botanical Section has fixed a new type called Pusa 52 which deserves to be better known. It compares well both as regards yield and rust resistance with the older selections and being a bearded variety it is not liable to damage by birds and animals. During the past season it gave 9,476 lb. of grain over an area of 4·22 acres or roughly 37½ bushels per acre.

With a view to evolving a type of tobacco which will resemble the American strains in flavour, colour and smoking qualities, while possessing the hardiness and growing qualities of the best Indian varieties, the American Adcock and Burley have been crossed with the well-known Pusa Type 28. Different methods of curing the leaf are being investigated. Very good results were obtained during the year in the curing of Burley by air-curing on racks, both with the split stem method and by stringing the leaves. Hybridization is being employed for producing a large-seeded race of linseed with a root system adapted to the Gangetic alluvium. Work on pigeon-pea is proceeding on two lines, namely, the separation of unit species from the mixed field crop, and the isolation of a type which will prove resistant to wilt disease. An experiment has been started during the year on the raising of sugarcane seedlings in Bihar. The results will be awaited with considerable interest, for, if the experiment is successful, it may be possible to discern, both earlier and more accurately, those types which are capable of withstanding the diseases and climate of Bihar. Oats, barley maize, gram, sesamum, safflower, *urid* (*Phaseolus radiatus*) and *mung* (*P. mungo*) are other food crops which are being systematically investigated for isolation of types superior both in yield and agricultural characters, to the mixtures at present grown.

Chemical Section. A successful method has been worked out during the year for the preparation of dicalcic phosphate from apatite, which is found in abundance in some parts of Bihar. The electrical process involved in its preparation is described in some detail in the report of the Agricultural Chemist. The study of the movements of nitrates in the soil and the subsoil has been extended in the third year to four areas treated as pasture, fallow, unirrigated cropped land and cultivated land receiving irrigation, respectively. The observations made during the year indicate that the distribution of nitrates in the soil, besides being regulated by rainfall and the nature of subsoil layers, is profoundly modified by the growth of crops and the cultural operations which the field receives. Experiments on the windrowing of sugarcane under Pusa conditions were

continued. Sugarcanes windrowed in the shade for 28 days compared favourably in quality at the end of that time with the crop standing in the field, and germinated well too when planted. It was also ascertained that sets of both fresh and windrowed canes germinated more quickly when soaked in water before being planted. Adsorption of moisture by soil, the changes occurring in the tobacco leaf under different methods of curing, and variations in the fat content of cow milk are other subjects of investigations in progress.

Bacteriological Section. The work on nitrogen fixation in soil by non-symbiotic organisms was extended to algæ, and it was ascertained that fixation of nitrogen by algæ alone can take place in India at any rate in liquid culture media. Further experiments carried out during the year have shown that by means of composting with sulphur the natural indigenous source of phosphate in the form of bones can be effectively utilized in place of imported superphosphate. The addition of a small quantity of charcoal to the compost has been found to enhance the rate of solubilization. Utilization of the activities of sulphur-oxidizing bacteria is now also being directed to the conservation of nitrogen derived both from urine and bonemeal. A successful trial was made in certain sugar mills during the last working season of the use of electrolytic chlorogen (E. C.) for reducing bacterial fermentation of the juice and the formation of invert sugar resulting therefrom. The method will hereafter be systematically adopted in practically all the factories in North Bihar. A systematic bacteriological examination of the milk supplied by the Pusa farm gives good grounds for the belief that the production of milk with a content of bacteria falling well within the limits allowed for Grade A milk in England demands only ordinary precautions, such as the use of "covered" milking pails and thorough steaming of pails, cans, etc. The Imperial Agricultural Bacteriologist devoted some of his time during the year to the preparation of cinema films of agricultural subjects.

Mycological Section. Further progress has been made in elucidating the factors affecting the pigeon-pea wilt problem and in interpreting the data obtained from the existing field

experiments. Special plots laid down during the year show that green-manure does not neutralize the presumed effect of superphosphate to the same extent as appears in the permanent manurial series. Estimations of moisture carried out in all the latter plots four times, to a depth of two feet, dispose of the theory often advanced that the highly wilted plants are water-logged. An investigation has been started on a new disease reported from Lower Burma as being the cause of the death of young cinchona plants. The preliminary observations made indicate that neither fungi nor bacteria are responsible for the symptoms which are probably physiological. An outbreak of a disease resembling collar rot, mosaic or yellow-stripe and chlorosis among the Coimbatore sugarcane varieties introduced in North Bihar, has suggested a complete survey of the disease in the province, with a view to finding out which varieties are susceptible to it. Fumigation and spraying experiments carried out in the Khasi Hills to combat the late blight of potato (*Phytophthora infestans*) demonstrated that potatoes treated with corrosive sublimate (1 grm. of $Hgcl_2$ in 1 litre of H_2O) and fumigated with petrol are least affected by this disease, and that Burgundy and Bordeaux resin mixtures are effective fungicides in the field. A comparative study of *Phytophthora Faberi*, *P. palmivora* and *P. Meadii* has been commenced with a view to ascertaining whether these three species are identical or different strains of one species.

Entomological Section. A serious caterpillar pest on coconut (*Thosea unifascia*) was investigated in the Andamans. The remedial measures carried out involved the cutting and burning of the leaves affected with caterpillars, the destruction of cocoons and the capture of moths by light traps. On the Pusa farm, *Brachytypes portentosus* was successfully controlled in a field of Roselle, by pouring petrol in their burrows, while *Pyrilla* spp. in sugarcane plots were effectively dealt with by spraying the canes with crude oil emulsion. Work on the life-histories and distribution of Tabanidæ was continued, and the possible transmission of rinderpest through the agency of *Musca domestica* and *Linognathus vituli* was further investigated in collaboration with the Director of the Muktesar Institute.

Infected insects were crushed in normal saline and the emulsion injected into healthy animals caused rinderpest, but all attempts to get the disease transmitted by natural methods failed. Observations on the lac-insect were continued with special reference to obtaining a parthenogenetic brood.

Agricultural Section. The permanent experiments being carried out in collaboration with other Sections of the Institute were continued. Though the continuous heavy rainfall of the monsoon resulted in a comparative failure of the *kharif* crop, very good fodder crops were raised on an area of 513 acres. The outstanding feature of the year was the success of the berseem crop. The area of 96 acres of irrigated land cropped with this new fodder gave an enormous yield and afforded excellent grazing for the herd of about 500 cattle from December till May. In March 1925, when the berseem crop was at its best, the average milk yield of 78 cows per day reached the record figure of 18 lb., while the annual average of 14·4 lb. per cow per day was higher than the previous year's figure by 1·5 lb. These yields compare well with those of good dairy herds in any part of the world. In the pure Sahiwal herd, 14 cows have given over 5,000 lb. of milk and of these six yielded over 6,000 lb. Among the half-bred Ayrshire-Sahiwal herd, 17 cows have given over 6,000 lb., and it is anticipated that 3 cows will very shortly give yields exceeding 10,000 lb. Three outstanding facts of practical importance have emerged from the data available from the cattle-breeding policy hitherto pursued, *viz.*, the prepotency of the sire in milk production, the shortening of the dry period by weaning the calves from birth, and the value of green food for dairy cows throughout the year.

Imperial Dairy Expert. On the farms at Karnal, Bangalore and Wellington, three of the best indigenous milch breeds are being improved by better feeding and selective breeding. Two of these indigenous breeds are being crossed with two of the most famous milch breeds of the West, *viz.*, the Ayrshire and Holstein. The experiment initiated during the year of transporting sterilized milk from Karnal for sale in Bombay and Calcutta—a distance of over 1,000 miles—has proved a success. It is believed that the only way to solve the milk problem in

urban centres is to produce it in rural areas where the cost of production is comparatively low and to transport it to urban centres where it can only be produced locally at a prohibitive cost. The Imperial Dairy Expert continued to co-operate with Provincial Agricultural Departments and City Municipal Corporations in the matter of giving advice and assistance in technical matters connected with the dairy and cattle-breeding industry.

Physiological Chemist. Feeding experiments were carried out with cattle foodstuffs in use at the dairy. In one of these experiments two lots of 6 heifers each were fed with varying amounts of roughage and concentrates for a period of 100 days ; four animals with Holstein blood stood out clearly above the others in their capacity for consuming roughage and for gaining weight. Interesting results were obtained in an experiment designed to determine the food cost of milk production in the case of cross-bred cows. The data obtained show that per pound of milk produced these cattle used the same amount of total nutrients as the American cows tested by Haecker, but required slightly more net energy per pound of milk. The experiment has been extended to a pure Indian breed—the Scindi. The Physiological Chemist prepared during the year detailed schemes of work on animal nutrition for the Madras and Mysore Departments of Agriculture.

Sugarcane Breeding Station. The transfer to Imperial control of the Coimbatore station has been placed on a permanent basis. It will now be possible to develop the work on thin and medium canes, and to start the breeding of thick varieties. During the year under report, over 200 cross-pollinations involving operations on about 1,500 arrows were made. These gave about 200,000 seedlings, a large number of which possess very satisfactory vigour of growth. It has been possible again this year to collect healthy pollen from the Mungo group of canes ; the 150 seedlings raised are quite distinct from those of other groups. Experiments are in progress to influence the fertility of the anthers in an arrow by suitable manipulations.

Sugar Bureau. As a result of the distribution of the three Coimbatore canes 210, 213 and 214 during the last four years for planting in North Bihar, there are now over 5,000 acres under these improved varieties in this tract. There was a brisk demand for seed-cane and over a lakh of maunds was distributed during the year from various centres. Thirteen more promising seedlings are at present under trial against the standard cane Co. 213. The sugar cable service conducted by the Bureau on a self-supporting basis continues to be appreciated by those who subscribe to it.

III. Training.

Agricultural Research Institute, Pusa. The second session of the post-graduate courses in Agricultural Chemistry, Botany, Mycology, Agricultural Bacteriology and Entomology, each extending over two years and qualifying for superior appointments in the Agricultural Services, commenced on 1st November, 1924. There were 32 candidates for admission. Of the six possessing the necessary qualifications chosen by the Selection Committee, one did not join and two left early in the year. The remaining three (one each for Agricultural Chemistry, Botany and Mycology) are undergoing training together with two (one each for Botany and Entomology) admitted in the previous year. The five post-graduate students of the Imperial Institute of Animal Husbandry and Dairying were given short courses at Pusa in estate management, cattle-breeding, plant-breeding, plant diseases, etc., during the last two months of their period of training.

In addition to these, two students took a special course in Entomology and one a special course in Agricultural Bacteriology. Eight students took short courses in Entomology and two in Lac-culture, and a batch of students from the Allahabad University visited the Entomological Section during Christmas week.

Imperial Institute of Animal Husbandry and Dairying. The fifteen-month post-graduate course in animal husbandry and dairying started on 2nd January, 1924, at the Bangalore Institute, was completed by five students during the year

under report. There were 21 applications for admission during the second session, and of these two were selected. For want of hostel accommodation there were no fresh admissions to the Dairy Diploma course, which is being taken by 13 students selected in the previous year. Short courses given at Bangalore and Karnal in cattle-breeding and dairying were taken by 12 students.

IV. Publications.

Seventeen memoirs, five bulletins and five other publications were issued during the year, while 19 publications were in the press on 30th June, 1925. The publications issued dealt with subjects of general importance such as the digestibility of Indian foodstuffs, factors determining the ripeness of sugarcane, flour phosphate as a manure for paddy, eradication of the weed *Cyperus rotundus*, inheritance of characters in Roselle, nitrogen fixation in soils of the Punjab, tamarind as a source of alcohol, bud and boll shedding in cotton and siloed *shisham* leaves as fodder for dairy cows.

"The Agricultural Journal of India," which is issued every two months, continues to maintain its popularity among the class of readers for which it is intended. It is proposed to increase its usefulness by giving more prominence to various aspects of animal husbandry and dairying which are at present receiving considerable attention at the hands of the department.

V. General Administration.

Buildings. By the construction of 12 clerks' quarters which have been completed during the year, the difficulty in the matter of housing accommodation on the Estate has been eased to some extent.

A general drainage scheme comprising the main building area of the Estate has been sanctioned during the year.

An out-patients block in the hospital attached to this Institute is now under construction.

The construction of a building for the Pusa High School, on a site close to the Estate area, is nearing completion. This will release considerable accommodation in the students' hostel of this Institute, where the school is now partly held.

Library. In addition to 348 periodicals and 2,273 books, bulletins, reprints and reports received in exchange, 276 periodicals and 442 volumes of new books, pamphlets, etc., were purchased during the year.

Hospital. Medical relief was afforded to 354 in-patients and 14,348 out-patients during the calendar year 1924 as against 312 and 13,463, respectively, in 1923. Among cases of the more important diseases of the Tropics, 398 were of *kala-azar*, 182 of hookworm disease, 98 of cholera, 52 of plague, 4 of leprosy, 154 of dysentery and 1,568 of malaria. Of the 2,480 operations performed, 103 were "selected" ones.

The Medical Officer (Mr. D. F. Michael) was engaged during the year under review in research on the epidemiology of *kala-azar* in and around Pusa for the *Kala-azar* Research Commission.

VI. Accounts.

The total expenditure during the financial year ending 31st March, 1925, as shown below, was Rs. 6,98,442 as against Rs. 7,06,557 during the previous year.

	Rs.
General expenditure of the Institute including the Agricultural Adviser's Office	3,05,198
Botanical Section	38,124
Chemical Section	49,721
Bacteriological Section	66,656
Mycological Section	44,820
Entomological Section	68,926
Agricultural Section	1,24,997
Total	6,98,442

The following are the principal items of expenditure out of the grant of Rs. 7,000 placed at the disposal of the Agricultural Adviser for expenditure in 1924-1925 on special agricultural experiments :—

	Rs.
Experiments with fibre extracting plant	226
Purchase of a disc harrow and a Turnwrest plough for the Karnal farm	326
Construction of three masonry water tanks at Pusa	1,092
Erection of a hydraulic ram at the Wellington farm	1,750

The receipts during the year from sale of publications, farm produce, milk and other articles amounted to Rs. 53,502 as against Rs. 36,421 last year.

REPORT OF THE IMPERIAL ECONOMIC BOTANIST.

(F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S.)

I. Charge.

Directly on return from leave in October 1924, the permanent incumbents of the posts of Imperial Economic Botanist and Second Imperial Economic Botanist, *viz.*, Mr. A. Howard, C.I.E., and Mrs. G. L. C. Howard, M.A., were deputed on foreign service for employment as Director and Physiological Botanist, respectively, of the Institute of Plant Industry, Indore, Mr. Howard to act also as Agricultural Adviser to States in Central India.

Maulvi Abdur Rahman Khan remained in charge of the Section until 25th August, 1924, when Dr. Shaw was recalled from leave to take charge of the Section.

Maulvi Abdur Rahman Khan carried out the work of the Section during his period of administration in an efficient and satisfactory manner. He was promoted to the post of First Assistant, in the Provincial Service Grade, with effect from 7th April, 1925. Babu Kashi Ram has done very good work during the year under review in connection with the tobacco investigation. All the staff have worked well.

II. Training.

Mr. Nand Lall Dutt, M.Sc., continued his training in economic botany. His work consisted in the study of the following subjects :—

(1) Hybridization and the inheritance of characters in tobacco, wheat and Roselle.
(2) Pure line cultures of gram, safflower and linseed.
(3) Technique of agricultural operations.
(4) Factors in the production of seed of lucerne.
(5) Anatomy of fibre yielding plants.

Thakur Ram Pratab Singh Chauhan, L. Ag., joined the Section as a post-graduate student in November 1924; he was the only student selected from a number of applications His course of study embraced the above subjects with the exception of the work on Roselle.

During the month of February 1925, a class of five students from the Institute of Animal Husbandry, Bangalore, attended a special short course in plant-breeding. The course lasted for 8 days and consisted of six lectures and 8 practical demonstrations during which the students studied the following subjects :—

(1) Unit species in linseed, gram, oats, barley, safflower.
(2) The isolation of a wilt-resistant type of *rahar* (*Cajanus indicus*).
(3) Types of tobacco and methods of curing the crop.
(4) Methods of cross-fertilization in tobacco and wheat.
(5) The improved varieties of various field crops growing in the Botanical Area.

The lectures were devoted to a simple survey of the principles underlying the conception of unit species and the Mendelian theory of inheritance.

Since February 1925, a considerable amount of work has been done in the preparation of diagrams, the collection of biometrical data and the calculation of constants with the object of rendering future courses more instructive to students. The Third Assistant, Babu Rakhal Das Bose, has been of material assistance in this work.

III. Investigations.

The cold weather season of the year 1924-25 was exceptionally favourable for agriculture in Bihar. The late rains resulted in optimum conditions of moisture prevailing in the soil, and in consequence the yields of all crops were very high. In the following table the yields of wheat, oats, gram, *rahar* and linseed, which were obtained in the Botanical Area in the year 1924-25, are shown together with the highest yields of the year 1923-24 for comparison. It will be seen that very good yields

were obtained from the wheats Pusa 4 and 52, and that the yields of all crops were very satisfactory.

Outturn of grain in 1925.

1925							
Crop	Variety	Plot	Area in acres	Actual outturn of grain	Outturn per acre		Highest outturn per acre in 1924
				Mds. Srs.	Mds. Srs.		Mds. Srs.
Wheat	Pusa 4	Pentagonal—Eastern border.	0·11	4 1	36 23		15 28
	,,	Pentagonal—Western border.	0·13	4 4	31 21		..
	,,	Riverside—Eastern plot.	0·76	26 27	35 4		..
	,,	S. T. G. No. 1	0·51	9 28	19 1		..
	,,	Punjab plots	3·00	46 8	15 16		..
	Pusa 52	Pentagonal field	4·22	115 1	27 10		17 4
	Pusa 80-5	Orchard 1 B—East	0·21	5 25	26 31		16 27
	Pusa 90	Orchard 1 B—West	0·21	5 21	26 12		15 24
	Pusa 6	Barah 6	0·44	10 12	23 16		12 19
	Pusa 12	Orchard 6A	1·57	32 8	20 20		..
	,,	Orchard 6B	1·44	33 28	23 12		21 4
	,,	Punjab plots	3·00	44 3	14 27		..
Gram	Type 25	N. T. G. No. 3 0·36 N. T. G. No. 8 0·34 N. T. G. No. 9 0·40	1·10	29 18	26 31		..
	Type 6	Western—Orchard border D.	0·09	1 16	15 22		..
	Type 17	N. T. G. 1	0·70	16 37	24 7		..
	,,	N. T. G. 2	0·37	9 27	26 6		..
Linseed	Type 121	Barah 1—West	0·65	10 20	16 6		15 33
	Type 12	Barah 1—East	0·71	10 10	14 17		15 0
Barley	Mixed	Barah 3	0·50	9 7	Cultures		..
Sann-hemp	Local	N. T. G. 6 & 7	0·80	9 0	11 10		..
Oats	Mixed	Barah 3	0·30	6 36	23 8		17 37
	Local	Barah 4	0·75	17 1			
	,,	Barah 5	0·47	10 36			
	,,	Musahars' plots	2·50	58 0			
	,,	Orchard—big plot No. 4A.	2·00	45 33	22 36½		..

Outturn of grain in 1925—concld.

Crop	Variety	Plot	Area in acres	1925 Actual outturn of grain	1925 Outturn per acre	Highest outturn in 1924
	Treatment :—			Mds. Srs.	Mds. Srs.	Mds. Srs.
Uspulun experiments with oats.	Soaked in water*	Lawn plot—Northern.	0·17	5 14	32 4	
	Treated with Uspulun	Lawn plot—Middle	0·17	5 39	35 34	
	Untreated	Lawn plot—Southern.	0·17	6 12	37 32	17 37
Pigeon-pea	Local	Barah 7	0·49	11 28	23 18	19 23
		Barah 8	0·50	11 30		
		N. T. G. 10 †	1·78	27 20	..	
		N. T. G. 11 †	0·39	6 20	..	
	Chupra	N. T. G. 5	1·00	28 32	28 32	

* Attacked seriously by smut.
† Also produced *khesari* 1 md. 15 srs. and 25 srs. respectively.

Wheat. The demand for pure seed of the Pusa wheats Nos. 4 and 12, which have now an established position in the agriculture of Northern India, is increasing. As the area available for the growth of these wheats in the Botanical Section is limited, six acres of land on the Pusa Farm was utilized in order to increase the amount of seed for distribution. The demand for seed of Pusa 52 was not large, as this wheat does not appear to be known to the public to the extent which it deserves. It is a bearded wheat of good standing power, rust resistance and yielding capacity ; during the past season it gave 115 maunds of grain over an area of 4·22 acres.

From the last harvest 282 maunds of wheat seed have been distributed as follows :—

	Mds.	Srs.
Pusa 4	65	36
Pusa 12	105	16
Pusa 6	7	20
Pusa 52	99	0
Pusa 80-5	3	17
Pusa 90	1	0
TOTAL	282	9

An attempt is being made to cross the Pusa wheats with the celebrated Australian wheat Federation.

In response to enquiries from foreign countries samples of Pusa wheats for trial were despatched to Rhodesia, Kenya, New South Wales and the Ukraine. Reports as to the success of the wheats in these areas are awaited.

Tobacco. The work on this crop forms one of the major lines of investigation in progress in the Section. The problem with which the cigarette-making industry in India is at present confronted is to obtain a type of tobacco which will resemble the American tobaccos in flavour, colour and smoking qualities, while possessing the hardiness and growing qualities of the best Indian varieties. Two types of American tobacco Adcock, the best of the cigarette tobacco, and Burley, which forms the basis of some of the finest pipe tobaccos, were selected for hybridization with the Pusa Type 28. During the past year all these types were grown in the Botanical Area with the object of obtaining pure line seed and of making a comparative study of the morphological characters of the three types. Some crosses were also made, and the first generation hybrids from these crosses are being grown during the coming season.

Experiments were also made in different methods of curing the leaf, as this side of the industry is at least as important in the final result as the production of improved races of the crop. Very good results were obtained in the curing of Burley by air-curing on racks, both with the split stem method and by stringing the leaves, the finished product in this case being scarcely inferior in colour and flavour to the product of the tobacco-growing States of America. The curing of the Adcock type of tobacco is more difficult, as this tobacco, like the indigenous types, does not ripen off in the field. Experiments, however, indicate that a slight modification of the rack method of curing may enable this type to be cured to the desired colour.

The whole of the crop of these tobaccos was sold to the factory at Dalsing Sarai and is being manufactured there for trial. It obtained the highest price on the market.

A collection of indigenous tobaccos was made from tobacco-growing centres all over India, and the various types were

grown in the Botanical Area with the object of obtaining pure seed for work during the coming season.

Owing to the change in the public taste the amount of seed of Type 28 which was distributed was much less than in previous years.

Linseed. The outturn of linseed during the past season was exceptional, Types 12 and 121 producing 14 and 12 maunds of seed per acre respectively. The unit species of the Indian linseed crop were maintained in culture and work on the hybridization of these species has been commenced. The types of linseed which are suited to the Gangetic alluvium are small-seeded, while those which are adapted to the conditions of Peninsular India are large-seeded and of higher oil-content. The root-system of the large-seeded types is not suited to the conditions of growth in the alluvium, and attempts are being made to combine the large-seeded character with the vegetative characters which are suited to the Gangetic alluvium by crossing between certain of the unit species. In this way it may be possible to obtain a large-seeded race of linseed which will be successful in Bihar and the United Provinces. The following quantities of seed of the Pusa types were distributed :—

	Mds.	Srs.
Type 12	1	25
Type 15	0	10
Type 46	0	5
Type 50	0	5
Type 55	0	5
Type 121	1	0
TOTAL	3	10

In response to enquiries from foreign countries samples of the Pusa linseeds were sent to Minnesota (U.S.A.), Mesopotamia and Soviet Russia.

The rust disease (*Melampsora Lini* (DC.) (Tul.) of linseed was severe on the majority of the unit species, but Types

12 and 121 were only slightly attacked. These latter are the two types which are specially recommended as giving heavy yields in Bihar. Wilt disease (*Fusarium Lini* Bolley) was the cause of a considerable amount of damage in certain types, and the variation in the incidence of this disease on different unit species of linseed is being investigated in collaboration with the Imperial Mycologist.

Safflower (*Carthamus tinctorius* Linn.). This crop has been under investigation at Pusa since 1908 ; the results of the earlier investigations deal with 24 types which were isolated from seed obtained from Bombay, Sind, Bihar and the United Provinces. These types were maintained in culture during the year under review, and in addition ten new types which had been isolated from seed obtained from Dacca and from Behea, near Patna, in 1916 were also grown. Out of these 10 types those isolated from the Dacca seed (Nos. 29 to 34) possess small seeds and a relatively low oil-content, but they are rich in carthamin and are spineless. This latter character may render them a useful fodder crop, and trials with some of these are being carried out by the Department of Agriculture, Bihar and Orissa.

Gram. The 24 types of gram were maintained in culture and the following quantities of seed, of the two best types, distributed :—

	Mds.	Srs.
Type 17	17	7
Type 25	23	20
TOTAL .	40	27

The wilt disease of gram appeared in the pure line cultures and was severe in the culture of Type 7, the remaining types being scarcely affected. An investigation is being carried out, in collaboration with the Imperial Mycologist, to determine the relative susceptibility of the different types of gram to this disease.

Samples of the Pusa grams were sent for trial to Algeria and Soviet Russia.

Arhar or pigeon-pea (*Cajanus indicus* Spreng). Work on this crop is proceeding on two lines, namely, the isolation of unit species from the mixed field crop and the isolation of a type which will prove resistant to wilt disease. In 1923-24 *arhar* seed was obtained from Chupra and sown in the Botanical Area. The result was disappointing as the crop yielded considerably less per acre than the local crop. In 1924, the *arhar* from Chupra was again sown, after mass selection had been carried out, and the resulting crop showed an increase of about 23 per cent. above the yield of the local field crop. When the isolation of unit species from this crop is completed, it will be interesting to observe whether any of the pure lines show an improvement on the mixed crop.

The attempt which is now in progress to obtain a type of *arhar* which will prove resistant to wilt disease has arisen out of the investigations of the Mycological Section on the incidence of wilt disease in the permanent experimental plots on the farm. In 1923, a number of plants which were growing in an artificially infected field were selected by the Imperial Mycologist as showing a certain amount of disease resistance. The seed from each plant was collected and sown separately in the same field in the next season. Thus the progeny of the plants which were selected in 1923 could be identified in the crop of 1924. Two of these progenies in 1924 appeared to possess a higher degree of resistance to the disease than any of the others, and, from a number of selected plants in these two lines, self-fertilized seed was obtained by the Botanical Section. During the year under review, this seed is being sown in an infected field in the Botanical Area together with seed of a type which is known to be very susceptible to the disease. It is hoped that in the following year variations in the incidence of the disease among the plants in this field will indicate the direction in which further selection should proceed.

Khesari (*Lathyrus sativus* L.). The work of the classification of unit species of this crop has been completed by Maulvi Abdur Rahman Khan, First Assistant, and the notes and seeds are being transferred to Mr. Howard, who is carrying on the

research in lathyrism. The following quantities of seed were supplied in connection with this research :—

	Mds.	Srs.
Khesari (*Lathyrus sativus* Linn.) . . .	3	13
Missya (*Vicia hirsuta*, Koch. Syn.) . .	2	39
Akta (*Vicia sativa* var. *angustifolia*) . .	11	3
Langra khesari (*Lathyrus sphœricus* Retz.) .	11	22
Pipra (*Lathyrus aphaca* L.) . . .	4	6

Sugarcane. An experiment was commenced, and is now in progress, on the raising of cane seedlings in Bihar. Cane seedlings have been successfully transported from the Sugarcane Breeding Station at Coimbatore to Pusa and at the present moment are growing well in the Botanical Area. The success of this trial is largely due to the skilful packing of the seedlings at Coimbatore; it remains to be seen, however, whether the plants will grow well and whether the raising of seedlings in Bihar will present any advantages. The fact that cane seed is harvested in Coimbatore during December-January, and that it does not retain its power of germination renders it impossible to germinate the seed in Bihar, as the seed if sent to Bihar would have to be sown at once and would certainly fail to germinate at the temperatures which prevail in Northern India at that season. An arrangement for germinating seeds under glass in a hot house would be required if this work were to be carried on in Bihar. The advantage of growing seedlings at Pusa is that the canes will be introduced to the Bihar climate at an earlier stage in their life-history, and by studying their growth, under the conditions for which the canes are intended, it may be possible to discern, both earlier and more accurately, those types which are best suited to withstanding the diseases and climate of Bihar.

Fibres. A field experiment to determine the influence of manurial treatment on the incidence of stem rot disease in jute has been commenced. A new type of jute, of superior quality and higher yielding power to any of the previous types, has been obtained from the Fibre Expert, Government of Bengal, and is under trial in the Botanical Section.

Type 3 of *Hibiscus cannabinus* was maintained and a small quantity of seed was distributed. In *Hibiscus Sabdariffa*

(Roselle), further investigations on the inheritance of colour in the capsule and corolla were carried out by Mr. N. L. Dutt, post-graduate student. Measurements of the pollen grains, leaf-factor and root-system showed that all four varieties were similar in these characters, the sole distinction between these varieties lying in the distribution of colour.

Oats. Nine types were selected from among the 35 types growing in the Botanical Area and will be grown together with seed obtained from other parts of India ; these types will furnish the basis for further selection work and for hybridization experiments with imported Scotch oats. An experiment to test the value of Uspulun as a seed steep for the prevention of smut was carried out and gave satisfactory results in controlling the disease. The control plot, which was sown with seed which had been soaked in water, gave a heavy outbreak of smut disease. Soaking the oat seed in water evidently enables the smut spores to germinate at just that stage in the life-history of the host at which infection is most virulent. The oat seed of the Botanical Section appears to be heavily infected with smut spores and will be treated against this disease in future.

Miscellaneous. Investigations upon maize, *til* (sesamum), *urid* (*Phaseolus radiatus*) and *mung* (*P. mungo*), chillies and peas have been commenced. Collections of these seeds were obtained from various parts of India and are being grown for the isolation of unit species. Thirty-one types of barley were selected from among the 130 types growing in the Section for a study of inheritance and the possible improvement of this crop.

The practice of distributing, free of cost, the improved varieties of seed produced by the Botanical Section was abandoned during the year under review, and a sum of Rs. 1,937 was realized by the sale of seeds, etc., produced in the Section.

IV. Programme of work for 1925-26.

Investigations will be continued on the lines indicated in this report on the following crops :—Cereals, oilseeds, tobacco, chillies, pulses, sugarcane, and fibre plants.

Particular attention will be given to the isolation of disease-resistant types of gram, linseed and *rahar*.

The collection and preparation of material and biometrical data for the training of students will be carried out.

V. Publications.

Summary of the Progress of Research in Agricultural Botany for the year ending 31st March, 1925, for inclusion in the Report for the Privy Council.

The Imperial Mycological Conference, by F. J. F. Shaw, D.Sc., A.R.C.S., F.L.S., *Agri. Jour. India*, Vol. XX, Pt. 1, 1925.

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST.

(J. Sen, M.A., Ph.D.)

I. Administration.

On the appointment of Dr. W. H. Harrison as Agricultural Adviser on 29th June, 1924, Mr. J. N. Mukerji assumed charge of this Section. Dr. Harrison returned on 24th October and held charge of the Section till 6th March, 1925, when he proceeded on 8 months' leave. Dr. J. Sen, Supernumerary Agricultural Chemist, who had returned from Dehradun on 1st March, 1925, took over charge on Dr. Harrison's departure on leave.

Mr. Bhailal M. Amin officiated as First Assistant from 29th June to 24th October, 1924. Mr. P. B. Sanyal officiated in the same post from 30th October to 25th November, 1924, during the absence of Mr. Mukerji on leave.

II. Education.

Two only of the three students selected for post-graduate training in the Section joined their courses in November. One of these, Mr. Srilal M. Seth, M.Sc., left in January. The other, Mr. A. T. Sen, M.Sc., is continuing his studies here.

III. Meteorology and Drain-gauges.

The meteorological and drain-gauge observations were maintained. The crops and drainage waters from the gauges were examined in the usual manner.

IV. General Analytical Work and Assistance given to other Sections.

A. The following samples were analysed and reported upon :—

Soils	19
Manures	20
Sugarcanes	64
Milk	2,387
Gur	1
Grass	1
Feeding stuffs	7
Opium	5
Miscellaneous	3
Total	2,507

Two samples of soil were received from a cinchona plantation near Mergui in South Burma. One was collected from a locality where the plants were dying in considerable numbers, while the other was taken from a place where the growth was good. The analytical figures revealed an interesting difference in the two soils as regards the content of phosphoric acid, and an application of suitable manures to the bad soil was recommended.

One of the manures received for examination referred to a sample of "mixed manure" marketed by a well-known firm who had a dispute with a Deputy Director of Agriculture regarding the composition of manures supplied. It was noticed that the ingredients of the manure were not homogeneously mixed, and apparently the reason of there being disputes about the composition lay in forwarding small quantities of imperfectly mixed samples of manures to the different chemists.

The sample of *gur* (unrefined, raw sugar) was an item of considerable interest. In a sugar factory in Bihar, lower yields of sugar were being obtained than what were to be expected from the polarimetric readings. No losses could be detected in the working processes. The *gur* was, however, found to have an abnormally high right-handed rotation. A careful examination of the *gur* conducted in this laboratory

revealed the presence of an appreciable amount of maltose which served to explain the abnormal results. The specific rotatory power of maltose is very high (+138°) as compared with that of sucrose (+66°). Moreover, the former is more soluble and is thus likely to be left in solution when the sucrose crystallizes out. It thus follows that, where maltose is present in the syrup, the crop of cane sugar crystals obtained is lower than what is estimated from the rotatory power.

The sample of grass was sent by a military dairy, with an enquiry about the possible presence of poisonous principles which fortunately were found to be absent.

The samples of opium were received from the Excise Department.

B. The following assistance was rendered to other Sections :—

Agricultural Section. Nine samples of manures, one feeding stuff, and 2,387 samples of milk were examined.

Botanical Section. A sample of manure, one soil and six samples of feeding stuff were analysed.

Sugar Bureau. Seven samples of soil, six of manures and 63 samples of sugarcane were reported on.

V. Research and Investigations.

Windrowing of sugarcane. The study of this subject has been continued by Mr. Sanyal, who has now written up his results for publication as a Memoir. Many of the observations have already been noted in the previous reports and they need not, therefore, be discussed in detail here. Mention may, however, be made of the principal conclusions arrived at. It was found that rainfall is the important factor determining the period during which sugarcane can be stored in good condition by windrowing in the field. A temperature above 25°C. was also observed to be harmful. It thus follows that, in Bihar, although it is often possible to preserve canes by windrowing them in the field during the cooler months, deterioration is apt to take place later in the season when the tempera-

ture rises and there is a likelihood of occasional falls of rain. If canes are windrowed in the shade and protected from the sun and rain, they can be successfully stored for longer periods than in the field.

The deterioration of windrowed canes is to be attributed to the enzymes present. The enzyme activity is checked and the quality of canes maintained, if internal movements of moisture are prevented, *i.e.*, if both quick evaporation from, and the entry of extraneous water into, the outer cell layers be stopped. When the canes are exposed to a fall of rain, water enters through the nodes where the concentration of invertase has been noted to be higher than that at the internodes. The passage of water through the nodes thus causes a translocation of the inverting enzymes into the internodes and consequently brings about a deterioration of the canes. The spontaneous decomposition of windrowed canes under high temperature conditions is most likely due to a rapid evaporation of moisture helping the diffusion of invertase from nodes to internodes.

Much of the reducing sugar which disappears when deterioration takes place, goes to form the new tissues (roots) of the germinating plants. It thus seems that the " deterioration " of windrowed canes is to be taken rather as an indication of the setting in of the process of germination of the buds. To study this further, a set of germination tests was carried out. A stand of Co. 213 canes was windrowed in shade for 28 days. The quality of these canes compared favourably with that of the crop left standing in the field.

Sets from these two lots of canes were planted in the field. Before being put in the soil, some of the canes were subjected to a preliminary soaking in water, the treatment being given to whole canes in some instances and to cut sets in others.

The results obtained were very promising and the experiment will be repeated the next season. There was a high germination of the buds of windrowed canes which demonstrated that the vital processes in these canes continue for a considerable period of time. It was further noted that sets of both fresh and windrowed canes germinated more quickly

when there was a preliminary soaking in water. This lends support to the theory that the entry of water diffuses the enzymes from the nodes to the internodes and thus stimulates germination. The germination was found to be quicker and more thorough when the canes were soaked in cut pieces (sets) than when whole canes were so treated. This is evidently due to the fact that the passage of water is quicker in the cut pieces.

The above results are of great interest to growers of sugarcane. The evolution of a successful method of having quick and uniform germination would permit a better utilization of the planting season. Improved crop results would ensue if the plants get a stronger and earlier start and if they get well established before the setting in of the trying period of summer drought.

The results are of significance from another point of view also. In the case of some quick-maturing varieties of canes the main crop has to be harvested early, leaving a stand of canes which would serve later for seed purposes. Besides the occupation of an extent of the field, this entails some expense and trouble for the protection of the crop. The canes are, moreover, liable to deteriorate and some of the buds germinate on the standing canes. In the case of such varieties, a decided improvement would be effected if recourse is made to a successful method of windrowing the seed canes till they are wanted for being planted out.

Sugar-beet. It has already been shown that satisfactory yields of good quality beets can be obtained at Pusa. The experiments carried out in 1924-25 were specially intended to ascertain whether the crop could be made to extend over a sufficiently long period after the cane season.

There were five plots, four of which were sown with beet seeds late in October, while in the fifth the sowing took place in the first week of December. From the first four plots roots were collected for analysis in the second weeks of March, April and May. The beets were found to yield 94 per cent. juice on all the occasions, the purity of the juice being about 85. The amount of sugar varied from 13·7 to 17·3 per cent. on the roots. From the last plot sown a sample was collected on

1st June. The roots contained 14·61 per cent. sugar and yielded 94 per cent. juice having a purity of 85.

The above results indicate the possibility of having supplies of good quality roots from the middle of March to the middle of May. If the sowings are later, the period can be extended by at least another fortnight.

As regards the yield, the crops on the plots, which varied in area from $\frac{1}{16}$th to $\frac{1}{8}$th of an acre, were from 10·3 to 12·5 tons of roots per acre, and the calculated amount of sucrose came up to 1·79 tons per acre.

The determination of available phosphoric acid in soil. The potassium carbonate method is being further investigated by Mr. Das. This method was already shown to be of much use in the case of calcareous soils. Other types of soil, *e.g.*, acid soils from Assam and Burma, laterite soils from Bengal and non-calcareous soils from Madras, have now been examined. The analytical figures obtained serve to differentiate between manured and unmanured plots and compare well with those given by Dyer's citric acid process. A few typical examples are recorded below.

Description of plots	Available phosphoric acid	
	Citric acid method	Potassium carbonate method
A. Acid soils.		
Borbhetta-Kharikatia plots—		
No manure	0·0023	0·0080
Super	0·0051	0·0112
Limestone	0·0019	0·0064
Limestone+Super	0·0050	0·0103
K_2SO_4	0·0020	0·0073
K_2SO_4+Super	0·0049	0·0129

Description of plots	Available phosphoric acid	
	Citric acid method	Potassium carbonate method
Borbhetta-Betjan plots—		
No manure	0·0027	0·0099
Manured	0·0041	0·0126
Borbhetta-Matelli plots—		
Bonedust	0·0039	0·0079
Bonedust + Fish guano	0·0042	0·0091
Acid soil, Burma—		
Bad, unmanured	0·0021	0·0025
Good, unmanured	0·0444	0·0260
No manure	0·0032	0·0037
Bonemeal	0·0097	0·0060
B. Laterite soils.		
North Hazi, Blocks B & C, Dacca—		
No manure	0·0021	0·0075
Bonemeal	0·0067	0·0099
Lime	0·0043	0·0065
Lime + Bonemeal	0·0127	0·0081
C. Non-calcareous soils.		
Permanent Plot, Coimbatore—		
No manure	0·0118	0·0010
P	0·0600	0·0016
N	0·0138	0·0010
N+P	0·0917	0·0026
N+K	0·0455	0·0016
N+K+P	0·0847	0·0026
Cattle manure	0·0139	0·0016
Cattle manure, residual; manuring discontinued since 1916.	0·0131	0·0017

These preliminary observations having turned out of a promising nature, the study is being extended to other soils of known manurial and cropping history.

Utilization of Indian deposits of apatite. A successful method has been worked out for the preparation of dicalcic phosphate from apatite, which is abundantly found in some parts of Bihar. This depends on the solution of the mineral in perchloric acid and the subsequent precipitation of the dissolved phosphoric acid as lime phosphate.

A solution of sodium perchlorate is electrolysed when perchloric acid and caustic soda are formed in the anode and cathode compartments respectively. The experimental conditions under which a high current efficiency is attained have been determined. The mineral phosphate is treated with the anode solution which extracts the phosphoric acid. The addition of a suitable proportion of the cathode solution causes the precipitation of dicalcic phosphate and the formation of sodium perchlorate. The sodium perchlorate thus regenerated can again be electrolysed and used. The phosphate of lime obtained by this process contains about 35 per cent. phosphoric acid (the amount theoretically present in dicalcic phosphate being 41·27 per cent.). Almost the whole of this phosphoric acid is citrate-soluble and so available to needs of plants, and in certain types of soils the product would be as effective as, or perhaps better than, superphosphate.

The Indian deposits of apatite are at present not being properly utilized. The high price of sulphuric acid stands in the way of their employment in the manuf cture o superphosphate. In the electrical process described above, there is no consumption of chemicals, as the sodium perchlorate used regenerates itself. If cheap electrical energy is available, *e.g.*, from natural sources of water power, it would be possible to provide Indian cultivators with an efficient phosphatic manure.

Tobacco curing. Mr. Mukerji's previous experiments on ground-curing and rack-curing processes have shown that

ground-cured tobacco contains a higher amount of " volatile nicotine " than does a rack-cured sample. The tobacco obtained by the latter process is thus of better quality, as it is the volatile nicotine which gives an undesirable sharpness and pungency to the smoke from certain types of tobacco. This year's experiments have been directed towards studying the course of changes which occur in the tobacco leaf under the three different methods of curing, *viz.*, ground-curing, rack-curing in shade and rack-curing in the sun. Various constituents of the leaf, *e.g.*, sugar, starch, nicotine, etc., are being examined in this connection.

Adsorption of moisture by soils. This subject is being studied by Dr. Sen. The adsorption of water by soils when exposed to a moist atmosphere is influenced by their content of clay, the relation being capable of being formulated as a log-log curve. The influence of temperature on the constants of the equation is being investigated. The work is of interest in that it may indicate a method of differentiating between varying types of soil.

Variations in the fat content of milk of selected cows. Samples of milk of nine cows, five from the Montgomery breed and four from the cross-bred (Ayrshire-Montgomery) herd, were examined twice daily for their fat content. In some of the cases, complete figures for the whole of the lactation period are not available, but the data collected generally show a gradual rise in the fat content with the progress of the lactation period. The milk having the highest fat content (6·5 per cent. average) was yielded by a Montgomery cow, Godaveri. The variation in the fat content of the milk of the Montgomery cows under observation was between 2·1 and 11·0, while in the case of the cross-bred cows the fat content was between 2·2 and 9·5. Towards the end of the year under review four more cows were included in the study. The milk of one of these latter, a cross-bred one, shows a singularly high variation in fat.

Permanent manurial plots. Experiments on the influence of manures on the composition of crops, which were started

in 1920, are being systematically carried on. Investigations of this nature must be continued for a series of years before definite conclusions can be authoritatively formulated, and it is therefore not necessary at present to enter in detail into the data obtained. But some of the general observations noted may profitably be referred to here. The experiment is being carried out in a series of nine plots having the following manurial treatment: (1) no manure, (2) oil-cake, (3) nitrogen, phosphate and potash, (4) nitrogen and phosphate, (5) nitrogen and potash, (6) phosphate and potash, (7) nitrogen, (8) phosphate and (9) potash. The manures are applied at the following rates :--80 lb. of nitrogen (as ammonium sulphate), 40 lb. of phosphoric acid (as super), and 40 lb. of potash (as potassium sulphate), per acre. As to the oil-cake, the amount applied is such as corresponds to 80 lb. nitrogen per acre. Ten crops, *viz.*, five monsoon crops (*marua—Eleusine coracana*) and five cold weather crops (oats 3, wheat 2), have been grown. Every season, the yields (total, as well as those of the constituents, *viz.*, grain, chaff and straw) from each of the plots are recorded and the amounts of nitrogen, phosphate and potash in the different constituents of each crop are determined.

Of the three plant foods, each used by itself, the effect of nitrogen has been very marked, specially on the *kharif* crop. There has been also a response to phosphate but potash has seldom increased the yield; on the other hand, it has rather depressed the yield at times. When combined with nitrogen, however, potash has given very good results. The application of oil-cake has produced most satisfactory results and has seemed to be better than the use of a complete mixture of artificials (N+P+K).

The above conclusions are based on the observations carried out during the first five years, 1920—1925. Whether the continued application of the manures will produce further modifications in the soil conditions and effect changes in the nature of the crop yields and the composition of the plants, is still to be seen.

The movement of nitrates in the soil and subsoil. As in previous years, this important subject has engaged the main energies of the Section. The study has now been extended to four areas under different cultural conditions, *viz.*, pasture, fallow, unirrigated cropped land, and cultivated plot receiving irrigation. This has entailed the collection and examination of 1,058 samples of soil during the year.

The observations are being still continued and it is not necessary to review the records in detail. Mention may, however, be made of some of the broad features observed.

The pasture area has carried grass for a number of years. When the first set of borings was taken here in the last week of May 1924, there was observed a very uniform distribution of nitrate in the soil layers, 0·7 to 0·9 lb. nitrogen per acre half foot being present. The soil was very dry up to the fifth foot; there was a rise in the moisture content of the following six inches of soil, with a fall in the next foot where a sandy layer intervened. Moist heavy soil came after that. At the time of the next collection of samples a month later, three inches of rain had fallen which served to moisten only the first foot of soil, raising its moisture content from 1·5 to 11 per cent. An occurrence of vigorous nitrification was simultaneously noted in this layer, there being more than 5 lb. of nitrogen per acre in the second half foot. The corresponding figure for the first half foot was, however, only about a pound, this being evidently due to a part of nitrate being washed down and a part consumed by the growing herbage. As the monsoon proceeded, the drainage became heavier and increasing amounts of nitrate were washed down into the lower depths. A recovery took place later on, as the rainfall decreased, and with the advent of the rains the distribution tended to be of the same type as that noticed the previous summer.

The second plot had been maintained as a clean fallow. When the first samples were collected in summer, the soil was found to be more moist than in the pasture area. As in the

pasture, the distribution of nitrate, except that in the upper layer of soil, was found to be pretty uniform, about 0·8 lb. nitrogen per acre half foot. Unlike the pasture, the fallow land was rich in nitrate, about 3 lb. nitrogen, in the topmost layer. This is to be attributed to the fact that the surface soil here had all along been kept disturbed. As noted in the pasture, in this plot too there was a quick response of the nitrification processes to rainfall. As the rains continued there was a loss of nitrates by movement of drainage towards the deeper layers. The amount of nitrates in the soil all along remained higher than in the pasture, and in contradistinction to this latter plot, the fallow area continued to be rich in nitrates up to March, after which the distribution began to assume the type noted the preceding hot weather. A very remarkable point noted in this plot was the high accumulation of nitrates, as compared to the amount present in the pasture area. This store of nitrates could no doubt have been of great benefit if a crop had next been grown on it.

The cropped area carried a stand of sugarcane which was cut flush with the ground in February-March 1924, and the land hoed and off-barred. The ratoons were allowed to grow. This second crop was harvested a year later and the land ploughed up. The distribution of nitrates in the soil of this field was quite different from that in the fallow but approximated to that in the pasture. The concentration of nitrates in the sugarcane area was practically uniform throughout the year in all the layers. An exception was, however, noticeable in the topmost half foot which was at times richer than lower depths, this concentration being apparent after the surface of the soil had been subjected to the operation of cultivation. The tendency of some of the deeper layers being high in nitrate, which was noticed in the pasture area during monsoon, was not observed in the case of the cultivated plot. In this connection it must be remembered that roots of canes reach much greater depth than do grass roots. Under a stand of sugarcanes nitrates from deeper layers of soils are, therefore, capable of being utilized than is the case in pasture land.

A set of figures illustrating some of the above points is appended herewith.

The results obtained show that the distribution of nitrates in soil, besides being regulated by rainfall and the nature of subsoil layers, is profoundly modified by the growth of crops and the cultural operations which the field receives.

VI. Programme of work for 1925-26.

Major subjects.

(1) Continuation of the investigation into the amount and nature of drainage water from cropped and fallow land.

(2) The influence of manuring on the composition of crop.

(3) The estimation of the available P_2O_5 by means of alkaline carbonate solution in calcareous and other types of soils and its correlation with cropping value and manurial reaction.

(4) The movements of nitrates and water in Pusa soils.

(5) A study of the chemical and physical factors involved in combined applications of green manures and superphosphates.

(6) Further investigations into the possibility of sugar-beet cultivation in Bihar.

(7) Variations in the quality of the milk from selected cows.

Minor subjects.

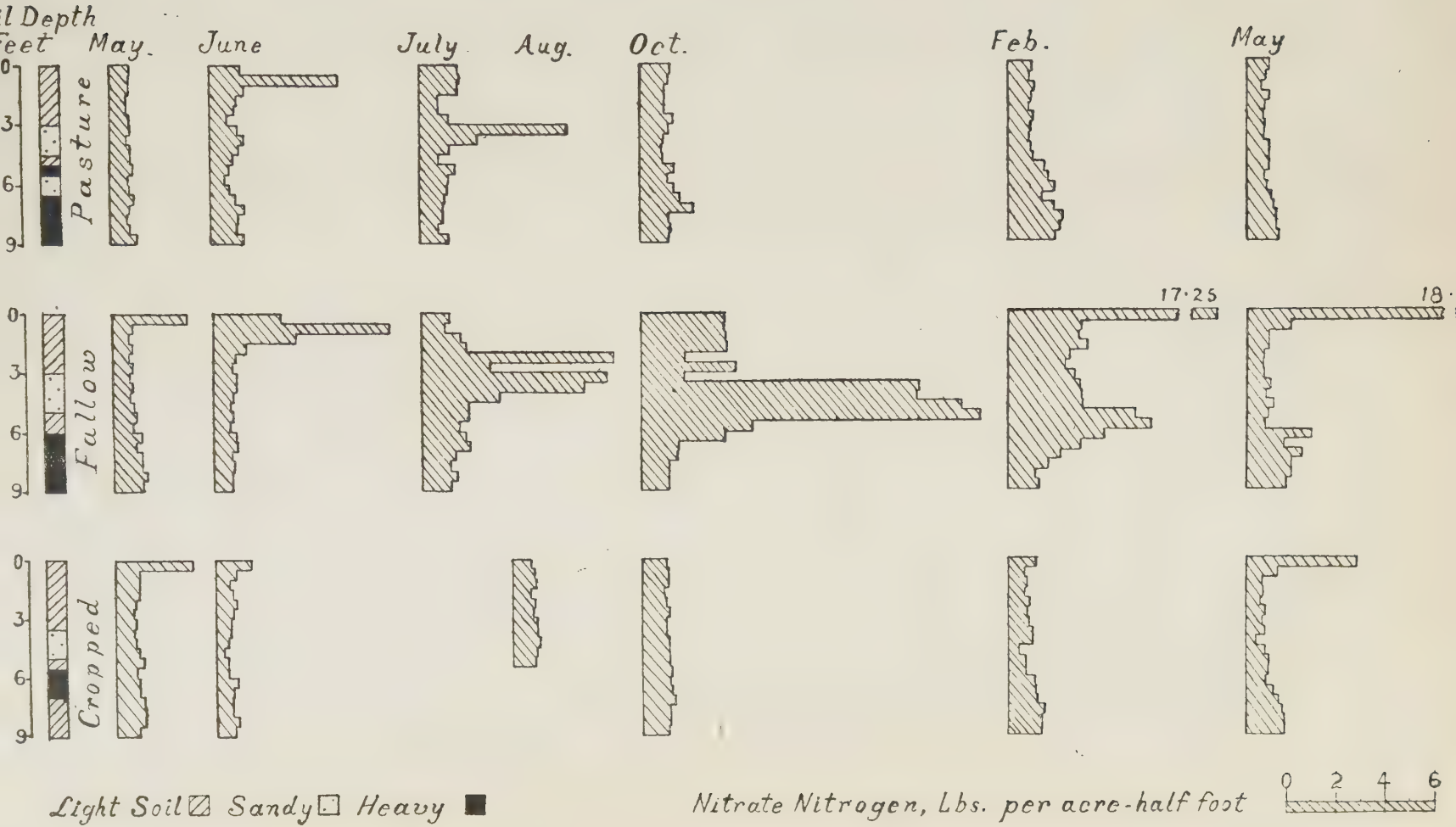
(1) A comparison of the accuracy of various analytical methods.

(2) Analytical work for other Sections.

VII. Publications.

Das, S. L. . . . The Determination of Available Phosphoric Acid of Calcareous Soils. *Mem. Dept. Agri. India, Chem. Ser.*, Vol. VIII, No. 6. (*In the press.*)

MOVEMENTS OF SOIL NITRATE, PUSA, 1924-25.



Mukerji, J. N. . . The Quality and Yield of Tobacco as influenced by Manurial and other Operations. *Mem. Dept. Agri. India, Chem. Ser.*, Vol. VIII, No. 1.

Sanyal, P. B. . . Deterioration of Sugarcane during its Storage by Windrowing. *Mem. Dept. Agri. India, Chem. Ser.*, Vol. VIII, No. 7. (*In the press.*)

Sanyal, P. B. . . Sugar-beet and its Possibilities in Bihar. *Agri. Jour. India*, Vol. XX, Pt. V, 1925.

Sen, J. . . . Report of the progress of Agricultural Chemistry in India for the year 1924-25, for the Committee of the Privy Council for Scientific and Industrial Research, London.

REPORT OF THE IMPERIAL AGRICULTURAL BACTERIOLOGIST.

(C. M. Hutchinson, C.I.E., B.A.)

I. Administration.

I held charge of the Section during the year under report.

II. Training.

Mr. Ko Ko Gyi, Assistant to the Agricultural Chemist, Burma, who was under training for a two years' course of agricultural bacteriology, completed his course on 23rd October, 1924.

The Assistant Bacteriologist delivered a course of lectures on dairy bacteriology of three weeks' duration to the Dairy Diploma students at the Imperial Institute of Animal Husbandry and Dairying, Bangalore.

III. Soil Biology.

Nitrogen fixation in soils. Further work on this subject included experiments to determine the possibility of independent fixation of nitrogen by algæ alone. Considerable differences of opinion upon this point have been expressed by workers in other countries, but the results of experiments at Pusa during the past year leave no doubt that fixation of nitrogen by algæ alone can take place in India at any rate in liquid culture media. Special precautions were adopted to exclude the absorption of nitrogen compounds from the air of the laboratory, although controls showed that this source of nitrogen was of insignificant importance. The considerable increases of fixation shown in soils exposed to light as compared with darkened controls accompanied with a correspondingly large growth of algæ strongly suggests the independent action of the latter in this respect. Attempts will be made to assign some definite ratio to the relative amounts of nitrogen fixation due to algal and bacterial action by making use

of the direct microscopic method of counting the latter. Further experiments on symbiotic action between algæ and azotobacter confirmed the conclusions of the previous year that such action enhances the amount of fixation.

The technique of direct microscopic counts of the number of azotobacter in soil was elaborated by numerous experiments ; the gelatin carbolic acid method was finally discarded in favour of the collodion method with Rose Bengal ; by the use of this method the effect upon the multiplication of azotobacter of various nutrients in culture was studied ; of all the substances tried mannite gave the greatest increase in growth and peptone the least.

The rate of nitrogen fixation varies greatly between different soils. Soil from Karnal in the Punjab was found to give high rates as compared with Pusa arable soil.

Fixation of nitrogen in mg. per 100 grm. soil.

Period	18-5-25 to 18-6-25	18-7-25
	Mg.	Mg.
Pusa soil+1 per cent. mannite	3·5	4·5
Karnal (No. 7) (alone)	14·5	13·4
Karnal (No. 7)+1 per cent. mannite . . .	25·0	24·0

A soil from Burma afforded an interesting example of the lime requirements of azotobacter.

Fixation of nitrogen in mg. per grm. of mannite in Ashby's solution in 31 days.

	Mg.
Burma soil without $CaCO_3$	6·65
Burma soil with $CaCO_3$	12·25
Pusa soil without $CaCO_3$	3·90
Pusa soil with $CaCO_3$	8·10

Conservation of cattle manure and urine. Utilization of the activities of sulphur-oxydizing bacteria was directed to the conservation of nitrogen derived both from urine and bonemeal.

It was found that the loss of nitrogen as ammonia during the fermentation of urine and the preliminary stages of decomposition of bonemeal in the soil and in composts could be prevented by the addition of sulphur in presence of the appropriate oxydizing bacteria, the ammonium sulphate formed being readily available as a nitrifiable source of nitrogen. Experiments to determine the economic value of this method are being carried out.

Solubilization of phosphates by sulphur bacteria. Further work was done on this subject, with special attention to bonemeal as a source of phosphate ; a large scale experiment was carried out in which one ton of compost started with inoculation with a culture of sulphur bacteria was subsequently used as an inoculum for a further quantity of 20 tons ; solubilization of the phosphate in the latter is proceeding rapidly at the time of writing.

The addition of small quantities of charcoal to these composts was found to have a remarkable effect in enhancing the rate of solubilization of the phosphate, this being probably due to the effect on the oxygen supply ; further work on this point is in progress.

Manurial experiments were carried out in which bonemeal sulphur composts were tested against superphosphate. The crops under experiment were *marua* (*Eleusine corocana*), wheat and potatoes ; these experiments were on too small a scale to yield conclusive results, but in every case the returns with the bonemeal sulphur composts were as good as, and in some superior to those with superphosphate ; large scale experiments will be carried out when sufficient material is available.

The general conclusion arrived at as a result of these experiments is that by means of composting with sulphur the natural indigenous source of phosphate in the form of bones may be effectively utilized in place of imported superphosphate. It seems probable that at the present price of

imported sulphur in India this method represents an economically possible way of dealing with the vital problem of the phosphatic requirements of Indian soils. The ideal alternative which should be seriously considered would depend upon the elimination of sulphur by making use of organic acids resulting from the bacterial fermentation of suitable organic matter; so far experiment has not found a way to attain by this method the same degree of efficiency as that arrived at by the use of sulphur; the fact remains, however, that in the fermentation of maize silage a pH of 3·8 can be attained which should allow of a considerable degree of solubilization of certain phosphatic compounds. The economic difficulty arises from the fact that in general the raw material containing sufficient sugar-yielding carbohydrates to produce effective quantities of lactic and other organic acids by bacterial fermentation is too valuable as a foodstuff to make use of as a source of manure. The problem, then, is similar to that connected with the production of industrial alcohol, namely, the provision of a sufficiently cheap carbohydrate material and one the use of which does not involve the diversion of the food supply into other channels.

In the meantime trial of the sulphur compost method should be made wherever phosphatic manuring is desirable.

Biological analysis of soil. Further work was done on the use of the CO_2 method for determining the availability of various soil constituents; measurements of CO_2 formed in soils and in soil extracts by bacterial action with addition of various constituents such as phosphates were compared with yields from complete nutrient solutions and from soils of known fertility. In this manner it was found possible to correlate the infertility of various soils with lack of sufficient available quantities of certain constituents; the value of the method naturally depends upon the assumption of a relation between general bacterial action in a soil and the specific bacterial activities necessary for fertility; such a relation has not been conclusively demonstrated as yet, and indeed so far as the final stages of nitrification are concerned work in this laboratory appears to show that such a relationship does not

exist; on the other hand, there is evidence that the rate of evolution of CO_2 bears a direct proportion to the activities of the bacterial flora responsible for the earlier stages of the decomposition of organic matter both nitrogenous and otherwise, including the process of ammonification, the antecedent to nitrate formation.

IV. Dairy Bacteriology.

Bacteriological examination of the milk supplied by the Pusa farm was carried on during the year. In the report for 1923-24 it was mentioned that for the months March to June 1924, the plate counts showed that the milk had a low bacterial content, and counts of over 10,000 bacteria per c. c. were exceptional. After the arrival of the monsoon, at the end of June, the plate counts were very much higher than they had been in the preceding hot weather. The average count on nine days between June 1st and 18th was 10,700; that of the three days (23rd to 25th), after the rains had started, was 52,000.

The average count for July was 33,000, and for October 26,500. The counts diminished from the start of the cold weather, and the average for the three months November 1924 to January 1925 was 16,000. In February there was a further drop to 8,300, after which counts rose to an average of 11,500 in March, 22,200 in May and 30,000 in June 1925.

Thus counts were considerably higher in the months March to June 1925 than they had been in the previous year. It is highly probable that the differences between the counts in these two years were due to the differences in character of the seasons.

In the hot weather of 1924 temperatures were very high, and the soil was parched and deficient in moisture. In 1925 temperatures were lower, the humidity of the air was higher than in the previous year, and the soil was well supplied with moisture.

Now one of the main sources of the bacteria in the milk at Pusa is the dirt dropping into the milking pail from the surface of the cow; this dirt, picked up by the cow from the

ground, was, owing to the heat and drought of the hot weather of 1924, a much less favourable medium in which bacteria could live and grow than it was in the succeeding year, and would therefore introduce fewer bacteria into the milk in 1924 than in 1925.

Experiments showed that the production of milk with a content of bacteria falling well within the limits allowed for Grade A milk in England demands only ordinary precautions, such as the use of "covered" milking pails and thorough steaming of pails, cans, etc., and milk bacteriologically of "Certified" standard can, with somewhat greater care, be produced.

Even the cleanest milk in this country ought to be pasteurized, if not at the dairy, then by the customer, not as a precaution against infection from tubercular cows, which are so common in Europe, but rare in India, but rather against infectious diseases such as cholera, enteric fever, and diphtheria, which may be introduced into the milk by an employee of the dairy who is a "carrier" of one of these diseases.

V. Disease of betel vines.

Further observations were made in connection with the causes and incidence of this disease. I visited a betel plantation in the neighbourhood of Howrah in company with the Director of Agriculture, Bengal, and saw the arrangements which had been made for trying the effect of the treatment by heating the soil, which I recommended last year. Direct inoculation of plants at Pusa with the bacterium isolated from diseased plants in Bengal failed to give conclusive results apparently owing to the healthiness and consequent natural resistance of the plants; later in the year, however, one or two plants showed symptoms of the disease, and the same bacterium was recovered from the stems; further attempts at direct inoculation are in progress.

VI. E. C.

Manufacture and supply of E. C. was continued to the Pusa Estate, the Dairy, the Hospital and the Veterinary

Dispensary. In addition, the Muzafferpore and Laheria Sarai Hospitals were supplied and also the Jails at Hazaribagh, Bhagalpur, Buxar, Sambalpur, Muzafferpore, Ranchi, Darbhanga, Purulia, Chhapra, Gaya, Bankipore and Motihari.

The total quantities supplied were—

	litres
Pusa	903
Muzafferpore and Laheria Sarai Hospitals . .	325
Jails	725

E. C. is now being made at Patna in the Central Hospita from whence supplies are sent to other civil hospitals in the province ; arrangements are being made to set up other centres of supply throughout the province.

Trial was made in certain sugar mills during the last working season of the use of E. C. for reducing bacterial fermentation of the juice and therewith the formation of invert sugar. Very favourable results were obtained and the method will be adopted as standard in practically all the mills in North Bihar.

VII. Photographic Section.

I continued in charge of the photographic work of the Institute during the year ; the use of panchromatic plates and light filters has now become standard practice for a large part of the work which, owing to the variety of subjects dealt with, varying from beetles and bacteria to cattle and crops, required special treatment to render the results suitable for use and reproduction as illustrations for scientific papers.

As it was considered advisable to make use of cinema films to illustrate the work of the department, I undertook to investigate the possibilities of producing some of these at Pusa so as to reduce the very heavy expenditures involved in utilizing the services of professional operators. It was found possible to make fairly good films of agricultural subjects even during the hot weather and rains, but the difficulties associated with the development and printing of hundreds of feet of film at high temperatures were considerable and the results reflect great credit on the photographic artist.

The following subjects were dealt with—

Cultivation. Indigenous plough and harrow and hand hoeing; English ploughs, motor and steam cultivation.

Harvesting. Indigenous hand harvesting; cattle treading out grain, hand winnowing. Self-binder harvester with motor tractor, steam threshing.

Dairying. Village milking and butter making. Pusa Dairy—milking and hygiene. Cattle feeding. Preparation of maize silage. Feeding calves by hand. Laboratory examination of milk samples.

At the request of the Director of the Tropical School of Medicine in Calcutta, I delivered two lectures there on the theory and practice of photo micrography. These lectures have been rewritten and will appear in the form of a paper in the "Indian Journal of Medical Research."

VIII. Programme of work for 1925-26.

This will involve continuation of work on all the subjects above reported on, both major and minor.

IX. Publications.

Hutchinson, C. M. . . The Control of the Biological Factor in Soil Fertility by Irrigation. *Agri. Jour. of India*, Vol. XX, Pt. IV, July 1925.

Hutchinson, C. M. . . Summary of Progress of Research in Agricultural Bacteriology in India for 1924-25, for the Committee of the Privy Council for Scientific and Industrial Research.

Hutchinson, C. M. . . Photography from the Microscope. *Ind. Jour. of Med. Res.* (*In the press.*)

Hutchinson, C. M. . . Micro-anatomy of Cimex with special reference to the Technique of Insect Histology. *Ind. Jour. Med. Res.*, Vol. XII, No. 3, January 1925.

HUTCHINSON, C. M., AND RAM AYYAR, C. S. — Loss of Sugar by inversion in Sugar Factories in Northern India and its prevention by Antiseptic Measures. *Pusa Agri. Res. Inst. Bull.* 163. (*In the press.*)

WALTON, J. H. . . — Preliminary Investigations in the Bacteriology of Milk. *Pusa Agri. Res. Inst. Bull.* 159.

JOSHI, N. V. . . . — Intensive Nitrifying Bed as a means of preventing Nitrogen losses from Cattle Urine. *Agri. Jour. of India*, Vol. XX, Pt. I, January 1925.

REPORT OF THE IMPERIAL MYCOLOGIST.

(M. Mitra, M.Sc., F.L.S.)

I. Charge and Establishment.

Dr. W. McRae held charge of the Section until 22nd April, 1925, when he proceeded on leave on average pay for seven months, and I assumed charge of the duties of Imperial Mycologist in addition to my duties as First Assistant. The post of Second Imperial Mycologist was kept in abeyance, and this, together with the abolition of the post of Supernumerary Mycologist last year, has considerably affected the output of mycological work in the Section.

II. Training.

Two students were admitted for post-graduate training in mycology in November 1924. One of them left the Section towards the end of December, while the other, Mr. S. N. Nanjundiah, B. Ag., is under training. Five students from the Bangalore Animal Husbandry and Dairying Institute received a course of mycological training for a short time in February and March, 1925.

III. Diseases of Plants.

(1) *Cajanus indicus.* The study of *rahar* (*Cajanus indicus*) wilt was continued by Dr. W. McRae and further progress was made in elucidating the factors governing the wilt problem and in interpreting the data given by existing field experiments. This year there was very little wilt till towards the end of the season when it developed rapidly. The numbers of wilted plants in the fourteen permanent manurial plots were in general accordance with those of previous years. The average number of wilted plants in the three plots treated with superphosphate was five times that in the five plots that got no superphosphate. The number in the green-manured plot was 0·1 of the average of those same five plots, while that

in the plot green-manured and treated with superphosphate was 1·7 times. We have now a record of eight seasons and because the wilt is vitiating the main purpose for which these plots were designed, *Cajanus indicus* will henceforth cease to be a crop in the rotation. Experiments have shown this year again that the bulk of the infection comes from the fungus in the soil and only a small proportion is carried by the seed.

Four plots of a quarter acre each that were tested last year and found to be wilt-free were grouped together in pairs and to one of each pair one hundredweight of superphosphate was applied. A line of infective material (pieces of *rahar* stem from wilted plants of last season's crop) was placed in the soil up the middle of each and the number and position of wilted plants recorded. The rate of extension of wilt from the infective line will show what is the relative influence of superphosphate. This experiment will be carried on for three or four years, depending on the rate of spread of the wilt, and it is hoped to be able to draw definite conclusions from the data supplied.

The North Pungarbi plots, where the influence of superphosphate is being compared with that of green-manure and superphosphate together, show that the wilt in the latter is only about 26 per cent. less than that in the former, indicating that green-manure does not neutralize the presumed effect of superphosphate to the same extent as appears in the permanent manurial series.

The Imperial Agriculturist with his usual kindness laid out thirty plots in Nepali all sufficiently isolated to prevent the spread of the disease in the soil from one to another, with the idea of testing the influence of superphosphate and green-manure on the wilt. The seed was disinfected before being sown but the amount of wilt this year shows that the soil of all the plots was too highly infected to be suitable for experiment. It also shows that the amount of wilt on the farm land is, this year, about eight per cent. which is comparable to the amount in the non-phosphate plots and in the surrounding neighbourhood. Thus there is no land immediately available on the farm at Pusa except the two pairs of plots already

mentioned suitable for testing the suggestions that arise from the incidence of wilt in the permanent manurial plots. *Rahar* has been grown by the Imperial Agriculturist in the Punjab Experimental Area in block D, which had no *rahar* during the last 20 years at least, and out of these, four plots of $\frac{1}{4}$ acre each have been placed at our disposal in lieu of the experimental plots in Nepali which have been discarded as mentioned above. The seed of a susceptible variety has been disinfected and sown in the whole area.

Seeds from 23 plants that last season remained healthy when all their neighbours died were sown again in land highly infected with wilt, and the progeny from two of them have again survived to a considerable extent. Plants in these two rows had been bagged and seed collected, and, in conjunction with the Imperial Economic Botanist, their progeny are being analysed and tested for resistance to wilt by sowing alternate rows of a susceptible variety and the bagged seeds in a highly infected land. The seeds were disinfected by 2 per cent. formalin for 20 minutes. In the above mentioned plot which has been showing infection during the last two years, *rahar* of a susceptible variety has been again sown and land again infected to observe and trace the further spread of disease in the uninfected portion of the plot.

The moisture in each three inches of soil down to a depth of two feet was recorded in all the 14 plots of the permanent manurial series of plots four times during the season, *i.e.*, once in May during the dry weather and three times in October, December and March when wilt normally appears. The amount varies within fairly wide limits throughout the season, but the amount of wilt shows no relation to the moisture content of the soil. At none of these times was the moisture content near the saturation point, and at the last three periods it was near the optimum moisture content. This disposes of the idea that has been advanced that the highly wilted plots are water-logged. Each time when the moisture observations were taken the hydrogen-ion concentration of the layers of soil was estimated by Gillespie's tinctorial method. It was found to be nearly the same in all plots and varied very little during

the season. These data, accordingly, give no clue to the conditions that govern the incidence of the wilt.

In order to see whether the toxic substances formed by the fungus are responsible for the wilting of *rahar* plants, the following experiment was carried on. *Fusarium udum* was grown in Richard's solution and after 16 days it was filtered through Chamberlain filter candle ; sterilized glass tubes with a bulb in the middle were inserted into *rahar* stems and roots. The filtrate was poured into the sterilized tubes and was allowed to be absorbed gradually into the stem and roots. In some cases sterilized and in others unsterilized filtrate was used. Controls were kept in which sterilized Richard's solution or distilled water was used instead of the filtrate. The experiment has not given any conclusive result up till now and will have to be repeated during this year.

A new canker disease was observed during the year in Pusa doing some damage. A *Nectria* sp. was found growing in the canker but examination of the earlier stages did not reveal any mycelium inside the tissue. The disease is under observation.

(2) *Cinchona.* A disease of young cinchona plants (*C. Ledgeriana*) in the Government plantation in Lower Burma was investigated by Dr. W. McRae. *Cinchona Ledgeriana* produces the bark richest in crystallizable alkaloid. The plants had been in the ground fourteen months and had grown as much in that time as plants three years in the ground in Sikkim. The quinine content, as reported, was also considerably higher than is usual in Sikkim. The chief symptom of the disease is that the collar of the plant swells to two or three times its normal diameter; the wood cylinder is only slightly swelled, most of the swelling is due to the thickening of the bark. The bark has many small longitudinal cracks, is darker brown and sometimes almost black. The lower leaves fall, leaving only those at the extremity of the branches which are narrower than usual. The plant shortly after dies.

These symptoms are not very characteristic, inasmuch as all can be found to a varying extent in plants that are apparently healthy though not all on the same plant unless it

is about to die. A great development of lenticels is also associated with the disease. They are more numerous, longer, broader and more open.

The bark on the swelling consists of two thickened layers, an outer brown layer of dead bark and an inner of pale yellow living bark into which brown patches extend up to and into the wood. Microscopic examination of the diseased tissue did not reveal the presence of any fungus or bacteria in either layer of the bark or in the wood. The protoplasm of the cells was slightly disintegrated but the nuclei were present and much starch was seen in many sections. The cell walls of the wood were stained pale yellow and the dark part of the bark had the cell walls of a deep brown. When the plants are dead, however, saprophytic fungi invade the dead tissue but they are not concerned with the cause of the disease. Neither fungi nor bacteria appear to be the cause but the disturbance seems to be physiological. The plants are growing on a low hill and the deaths are more numerous on the flat top and on the slope exposed to the south-west monsoon, while growth is better on the sheltered side. On a quarter of an acre on the top of the hill 18 per cent. of the plants have died, but on the whole field of about 20 acres the percentage of death was only three. So far the damage is not really great, though the death rate on the top of the hill is rather alarming. *C. Ledgeriana* is not usually grown at such low elevation (300 to 500 feet) and during the introduction of cinchona into various parts of India in the sixties and seventies of last century, *Calisayo*, of which *Ledgeriana* is a selection, generally failed to grow profitably at low elevation. It is probable that here the limit of plasticity of the physiological requirements of the species has been well nigh reached. It may be that too high a temperature is causing unbalanced development. Mr. Russell, the Superintendent, who has had a long and successful experience in growing cinchona, is inclined to think that the cause is insufficient drainage and the full force of the monsoon to which the plants are exposed ; to get over this he is going to open drains and leave belts of uncut jungle trees as a wind-break. It is likely that when local seed becomes available, as

it will in three years, the plants grown therefrom will be less liable to this unbalanced development as they will have come from plants that have adapted themselves to the conditions or are tolerant to them. It may well be that the rapidity of growth and the high quinine content are well worth having at the cost of some plants that cannot live at this elevation. The experiment of growing cinchona at this elevation is in no way jeopardised as far as it has gone ; indeed it is very promising.

From a few plants, *Botryodiplodia theobromæ*, a disease common in the Eastern Tropics on cocoa, coffee, tea and rubber, was isolated but this fungus is not the cause of the disease just described. *Corticium javanicum*, pink disease, was also isolated from a very few plants of *C. Succirubra*. It is a disease having over 200 known host plants and so is inevitable but controllable.

An investigation into diseases of this host in the Sikkim plantations has led to the isolation of quite a number of fungi that possibly cause disease. A bleeding disease, a bark disease and two root diseases are specially being investigated, and inoculation experiments are being carried out to find out the pathogenic nature of various fungi isolated.

(3) *Sugarcane diseases*. A fairly serious disease broke out in one of the Coimbatore sugarcane seedlings (Co. 213) and to a slight extent in another (Co. 210), recently introduced into Bihar and doing very well up till last year. The symptoms of the disease closely resemble those of collar rot in the yellowing of the leaves, stunted growth, hollowing out of the pith and lightness of the mature cane. The disease was more common on low lands where water accumulates during rain, and on examination of diseased clumps it was found that the root-system was not fully developed and some of the adventitious roots were rotten and decomposed. In many cases root borers were also present. Several fungi were isolated from diseased canes, *viz.*, *Rhizoctonia* sp. *Colletotrichum falcatum*, *Cephalosporium Sacchari*, *Verticillium* sp., and a sterile Phycomycete. In addition to the above, two sterile fungi belonging to Basidiomycetes group, one of which was found almost plugging the vessels of xylem and the other cover-

ing all the dead roots, collar and leaf-sheath, and another fungus very much like *Hendersonina Sacchari* Butl. was isolated. The latter was found by Butler to be the causal fungus in a very similar disease in Assam, Coimbatore and Mysore. In order to investigate the disease fully and to warn the growers regarding its spread, an extensive tour was made in Bihar and it was noticed that the disease was very common in almost all places visited. An area of about 70 acres of Co. 213 and 8 acres of Co. 210 was rejected for seed purposes in different factories. A careful clump selection was undertaken in Pusa to check the spread of disease.

The disease is under study and inoculation experiments are being carried on to determine the pathogenic nature of different fungi isolated and to find out the principal causal organism responsible for the disease.

Ustilago scitaminea Syd. was observed on Co. 213 and all growers in Bihar were instructed to destroy smutted clumps and not to use them for seed purposes. A report was received from the Director of Agriculture, Punjab, that sugarcane smut was spreading in many districts and doing a good deal of damage. Advice and instructions were given regarding selection of clumps and introducing immune varieties.

A disease something like mosaic or yellow stripe and chlorosis has been observed during the year in a good many varieties of Coimbatore seedlings grown in Pusa, but the infection is very slight except in Co. 213 and Co. 232 where it was found to be less than 5 per cent. It was also observed on Palur and Samalkota farms (Madras Presidency) as attacking many varieties of canes grown there, but only A.95 and Purple and Red Mauritius showed more mottled leaves while the rest showed only very slight infection. Up till now this so-called disease has done very slight damage. A complete survey of the disease in Bihar has been undertaken to find out which varieties are susceptible and whether any are immune, and canes showing symptoms of disease are kept under observation to see whether it is really mosaic.

Some sets of Badilla or N. G. 15, which is one of the world's finest canes and certified as free from mosaic or yellow stripe

disease, are being grown in Pusa by the Secretary, Sugar Bureau, under strict quarantine, and these have been kept under observation to see whether they show any sign of yellow stripe under Indian climatic conditions.

(4) *Gram.* Experiments conducted during the cold season of 1924-25 with gram seeds obtained from Burma and supposed to be susceptible to wilt gave no definite result. Infection experiments by heavily inoculating the soil in pots and seeds were carried out but no wilting occurred. Field experiments with Burma seeds did not produce wilt under Pusa conditions. Wilt was recorded for the first time in Pusa in a variety T. 7 which was free for the last 15 years. This strain of *Fusarium* was brought into culture, and it was found that it differs from other strains isolated from wilted plants received from various places in India. Infection experiments will be repeated and all the varieties of gram growing in Pusa will be tested, in conjunction with the Imperial Economic Botanist, to ascertain which are resistant and which are susceptible varieties.

(5) *Linseed.* The linseed wilt has been found doing some slight damage at present in Pusa. Its study has accordingly been taken up and a *Fusarium* sp. has been isolated. Preliminary inoculation experiments were carried out and the study of the fungus has been commenced. Inoculation experiments will be carried out this season in conjunction with the Imperial Economic Botanist on the same lines as wilt of gram.

(6) *Berseem.* A disease of berseem (*Trifolium alexandrinum*) is under study. A *Fusarium*, a *Vermicularia* and a *Rhizoctonia* were isolated from dying plants. Inoculation experiments were carried out by infecting seeds or soil in pots and by inoculating seedlings with the above mentioned fungi. *Rhizoctonia* only has infected so far, killing 70 per cent. of the inoculated plants.

(7) *Cucurbitaceæ.* Inoculations and cross-inoculations were carried on with all the six strains of *Pythium* isolated from various Cucurbitaceæ plants at Pusa, as mentioned in last year's report, to determine their parasitic nature, and it was found that they readily infect their host plant and each other. They as well as a culture of *P. Butleri* were inoculated into papaya,

chilli and tobacco plants. The latter acted normally, but the former while infecting papaya did not produce the foot rot in papaya and infected chilli and tobacco feebly. The morphological study of all these strains of *Pythium* on Cucurbitaceæ was made, and it was found that these strains agree with *P. Butleri*. The inoculation experiments are being repeated.

(8) *Potato.* An enquiry was made into the diseases affecting potatoes in Khasi hills (Shillong) which do a good deal of damage both in field and in storage, especially to the summer crop which suffers from ravages of the late blight (*Phytophthora infestans*). The damage is reported to be so great that many cultivators have given up this crop and the others are leaving potato planting, though this is the most important crop in these hills. The local name for the late blight disease is *Pangiong* meaning in Khasi language " black disease." The winter crop suffers very little from disease of any kind, but the yield is poor, and its main use is to furnish seeds for the spring sowing; the greater amount of seed is kept from the last summer crop which is more important from the point of view of yield.

The chief cause of the trouble is that seed is not selected properly by Khasi cultivators either before sowing or at the time of storing. The dead and infected portions of the plants are allowed to remain in the soil; no rotation of crops is practised except on the Government Agricultural Farm, Upper Shillong. Rejected seeds are given to cattle and cow-dung used for manure, and very bad potatoes are either left in the field or are put in manure pits. Seeds that are totally bad are rejected but seeds that show the slightest sign of sprouting even though affected are sown. All this is due to their ignorance of the fact that bad seeds instead of giving any yield will infect the soil more. The climatic conditions also favour the spread of the disease, and for checking the disease no proper spraying is done. The examination of the storage godowns of the Agricultural Experimental Farm, Upper Shillong, and of some of the cultivators showed that a good number of the potatoes stored were attacked with *Phytophthora infestans*

which gave very offensive smell. A very great number were attacked by *Fusarium* causing dry rot and wet rot due to bacteria. These organisms had infected and spoiled a very great number of potatoes. The damage after $2\frac{1}{2}$ months of storage was found to be up to 20 per cent., and it can be imagined what it could have been after a storage of six months. Besides the above mentioned fungi causing storage rot, *Oospora Scabies* Thaxter, *Verticillium* sp. and a few cases of *Rhizoctonia* were noticed. *Pythium artotrogus* De Bary was also found growing individually or associated with *Phytophthora infestans*. In order to find out a suitable method of checking the disease in storage and in field, a thorough selection of the seed potatoes on the Agricultural Farm, Upper Shillong, was made. They were then treated before storing, and at the time of sowing a vigorous selection of healthy seed was made, and spraying was done when the plants were about 6″ to 8″ in height. A preliminary experiment for seed treatment was done as follows.

A quantity of selected seeds was treated with a solution of corrosive sublimate (1 grm. of $Hgcl_2$ in 1 litre of H_2O) for one hour, the potatoes were then dried and subjected to petrol fumigation in an air-tight room at the rate of 1 pint petrol to every 200 cubic feet of air space for 24 hours and then stored in sand. Another lot of seeds was stored in sand and subjected to fumigation as above without any treatment with any chemical. A third lot of selected seeds was treated with formalin solution (1 pint of formalin to 25 gallons of water) for 2 hours, dried and stored in sand. Lastly, a fourth lot of potato seeds was simply selected and stored in sand. As the seeds were already stored at the time of treatment, potatoes in large numbers could not be treated. The result of the above experiment showed that potatoes treated with corrosive sublimate and fumigated with petrol were the best preserved, the number of the diseased seeds sorted out from them being less than in any other. This experiment will have to be repeated on a larger scale this year.

At the time of planting, a vigorous selection of healthy seed was made and besides giving instructions for all precautionary measures the importance of discarding diseased or

slightly diseased seed was explained. For seed purposes it was suggested to have winter seed as far as possible, and since it remains in storage for a short period, it is not much affected by disease. The chief difficulty in Shillong is that at an elevation of 5,000 to 5,500 feet the winter crop gives a poor yield.

Spraying was commenced when the crop was 6″ to 8″ in height, and 16 acres of the potato crop on the Agricultural Farm, Shillong, were sprayed with two powerful hand sprayers using 100-120 gallons of the fungicide per acre. Three fungicides were tried, *viz.*, Bordeaux mixture, Bordeaux resin mixture and Burgandy mixture. The method of preparing stock solutions of the above mentioned fungicides was demonstrated, and the importance of preparing the mixture accurately and spraying properly was impressed. The whole of the first spraying was done under our supervision, and the Farm Manager was asked to carry on the second and third series of spraying. It was found that Burgandy and Bordeaux resin mixtures are better than Bordeaux mixture as they are less easily washed away by constant rain. In addition to *Phytophthora infestans*, *Alternaria Solani* and *Corticium vagum* rot due to *Fusarium* and bacteria were found in the field. The disease is still under study.

It has been reported that late blight of potato is doing considerable damage in Patna, Dinapur and Bihar. The disease is appearing for the last few years but the damage during the last year was considerable. The cause of the disease in these places appears to be the same as that found previously in other places on the plains of Northern India, *i.e.*, the use of infected seeds from Darjeeling Hills.

(9) *Jute.* With the transfer of Dr. Shaw to the Botanical Section the experiments on the influence of manurial treatment on the incidence of disease in this crop have been handed over to that Section. The field experiments which were laid down on the farm in the year 1924 failed to give any result, as the exceptional lateness of the monsoon prevented the germination of the first sowings. The germination of subsequent sowings was so late that the crop never grew to a size which

would allow of any conclusions being drawn. The experiments which are now in progress in the Botanical Area are on irrigated land and should be free from this defect.

(10) *Oats.* An outbreak of smut in oats in the Botanical Area was reported by the Imperial Economic Botanist. Three plots were sown by the Imperial Economic Botanist, of which one was untreated, the second was treated with Uspulun and the third had seeds soaked in water. It was interesting to note that smut was most (4 per cent.) in plots where seeds were sown after having been soaked in water, and slight (0·13 per cent.) in the plots which received no treatment, while the plot with seeds sown after having been treated with Uspulun was free. The seed was all from the same bag and was uniform. It appears that smut spores that were adhering to the seeds must have germinated when the seeds were soaked in water and penetrated the seedlings.

(11) *Helminthosporiose.* The work on *Helminthosporium* on cereals was continued and another species on *Panicum frumentaceum* has been brought into culture. Inoculation experiments to see the parasitic nature are being carried on and morphology studied. The morphological and physiological study of a species found on ginger was made and experiments to test its parasiticity are still in progress.

(12) *Piricularia.* The inoculation experiments with a strain obtained from *Oryza sativa* in Pusa and Coimbatore are being carried out on *Oryza sativa*, *Hordeum vulgare* and *Eleusine coracana.*

(13) *Phytophthora.* A comparative study of *Ph. Faberi* Maubl., *Ph. palmivora* Butl., and *Ph. Meadii* McRae, has been commenced with a view to ascertain whether these three species are identical or different strains of one species. Physiological study and cross-inoculation experiments are in progress.

IV. Systematic work.

One hundred and fifty specimens from within and outside India were added to the herbarium. Sixty-four specimens of various hosts and eighteen cultures were supplied to workers in mycology in various parts of the world.

V. Programme of work for 1925-26.

1. *Research work.* New diseases of Indian crops that come to the notice of the Section will be investigated. The following crop diseases will receive special attention :—

(*a*) Diseases of cereals.
(*b*) Diseases of sugarcane.
(*c*) Diseases of *rahar* (pigeon-pea).
(*d*) Diseases of gram and linseed.
(*e*) Diseases of cinchona.

2. *Systematic work.* This will be carried out in conjunction with the Imperial Bureau of Mycology in London. Steps will be taken to print supplements to the list of specimens in the Pusa herbarium for the assistance of the provincial sections of mycology.

3. *Training.* Students and assistants will receive training on the lines indicated in the prospectus.

4. *Routine work.* Advice and assistance as required will be given to other departments and the general public.

VI. Publications.

McRae, W. . . . Report on Mycology, 1924-25, for the Committee of the Privy Council for Scientific and Industrial Research.

McRae, W. . . . South American leaf disease of Para Rubber. *Agri. Jour. India*, Vol. XX, Part IV.

Shaw F. J. F. . . Studies in Diseases of the Jute plant. (2) *Macrophoma Corchori* Saw. *Mem. Dept. Agri. India, Bot. Ser.*, Vol. XIII, No. 6.

REPORT OF THE IMPERIAL ENTOMOLOGIST.

(M. Afzal Husain, M.A., M.Sc.)

I. Administration.

Mr. T. Bainbrigge Fletcher remained in charge of the Section till 27th April, 1925, when he went abroad on 18 months' leave. Mr. M. Afzal Husain was appointed Offg. Imperial Entomologist, and remained in charge for the rest of the year.

II. Training.

The following students received training during the year under review :—

A. B. Misra, M.Sc., Research Scholar, Lucknow University ; Systematic Entomology (May to July 1924).

H. D. Nangpal, M.Sc., Indian Central Cotton Committee Scholar ; Systematic Entomology and research technique (June-July 1924).

F. D. Peries, Ceylon Government Student ; General and Applied Entomology, particularly pests of rice and vegetables (June 1923 to January 1925).

T. V. Venkata Krishna, L. Ag., General and Applied Entomology, particularly parasites of sugarcane pests (February 1924 to January 1925).

S. Mukerji, M.Sc., Post-graduate Student ; admitted 1923 ; General and Applied Entomology. Carried out research on *Aphis sacchari*, *Embia minor* and Agromyzidæ (November 1923-1925).

Alfred Ba Te, B.Sc., Systematic Assistant to the Entomologist, Burma ; Systematic Entomology (November 1924 to April 1925).

E. Heber, Artist to the Indian Lac Association for Research ; Training in artist's work.

Besides the above, a batch of students from the Allahabad University visited the Entomological Section during Christ-

mas week, and a batch of 5 Honours School students of the Punjab University were given a short course of a month's duration on Systematic Entomology.

Two students were trained in Lac-culture, one of whom was from Suthalia State (Central India).

III. Insect Pests.

Observations on the pests of crops, vegetable and fruit trees were continued. A number of insects were reared in the insectary and coloured plates showing various stages of the more important ones were prepared.

The following pests were especially noted during the year :—

Aphis sacchari was noted for the first time in fairly large numbers on canes at Pusa. The two closely allied species of scale-insects (*Pseudococcus sacchari* and *Pseudococcus sacchari-folii*) also occurred in numbers. *Aspidiotus* sp. attacked some of the varieties of cane and the badly infected canes dried up prematurely. *Eretmocera impactella*, normally a pest of *Amaranthus* spp., was found, during the latter part of the season, in fairly large numbers, on beet in an experimental plot. By webbing up the cauline leaves and nibbling at them, the growth was affected to a certain extent. *Cosmophila indica* was troublesome on *Hibiscus esculentus*.

The following alternative food-plants were ascertained for some of the serious insect pests :—

Insect pest	Food-plant
1. *Perigea capensis*	*Vicoa vestita* (*Compositæ*).
2. *Chloridea obsoleta*	*Antirrhinum majus* (Scrophulariaceæ).
3. *Plusia nigrisigna*	*Vicoa vestita*.
4. *Plusia orichalcea*	*Carom copticum* (Umbelliferæ).
5. *Cosmophila sebulifera*	*Corchorus fascicularis* (Tiliaceæ).
6. *Acherontia styx*	*Clerodendron infortunatum* (Verbenaceæ).
7. *Lesioderma testaceum*	Cotton seeds.

A serious complaint of a caterpillar pest of coconut palm was received from the Andamans. The investigation was carried out by the Second Entomologist and one Assistant and a Fieldman, and they remained at the spot for one and a half months. The pest was identified as *Thosea unifascia*. Wlk. (Lepidoptera). Remedial measures carried out consisted of cutting and burning the leaves with caterpillars on them, destroying cocoons, and capturing moths by light traps.

A sporadic outbreak of *Cirphis unipuncta*, Haw. was reported in December 1924 from many localities in Bihar.

Many consignments of insects were received from correspondents and necessary identification and advice were given as far as possible.

Control measures against *Monophlebus octocaudata*, Gr. Coccidæ) were undertaken and various kinds of bands were prepared to stop the descent of adult females down to the ground where eggs are laid. *Brachytypes portentosus* (Orthoptera) was bad in Roselle in the Botanical Area and was successfully controlled by pouring petrol in its burrows. An outbreak of *Schizodactylus monstruosus* was checked effectively by the use of poison baits. Spraying with crude oil emulsion was done against *Pyrilla* spp. on experimental sugarcane plots.

After many unsuccessful attempts, adult insects belonging to family Thyrididæ were bred out from galls found on twigs of *Phyllanthus emblica*.

Pathological Entomology. Work on the life-histories and distribution of Tabanidæ was continued. The papers published by Mr. P. V. Isaac are given in the list of publications. Mr. S. K. Sen worked at the Veterinary Research Institute, Muktesar, for four months during the year on rinderpest transmission. The report of his work has been accepted for publication as a Memoir of the Department of Agriculture. He mainly worked with *Musca domestica* and *Linognathus vituli*. Infected insects were crushed in normal saline and the emulsion injected into healthy animals caused disease, but all attempts to get the disease transmitted through these insects by natural methods of transmission failed.

Chrysomyia bezziana extracted from a malignant growth on human heel was fed on meat, and out of seven larvæ two pupated and one fly emerged. The same species was bred from a case of nasal myiasis from the Pusa Hospital. Several interesting species of myiasis-producing larvæ, from subcutaneous tissue of an elephant, were received from the Veterinary Department, Burma. An illustrated note on these flies has been sent for publication in the "Bulletin of Entomological Research."

IV. Bees and Lac.

Bees. Enquiries regarding apiculture were dealt with and standard pattern hives were obtained and supplied. There is a rapidly growing demand for a suitable variety of bees and the question of employing a whole-time expert deserves consideration.

Lac. The emergence of larvæ took place during the second week of October 1924 and on 1st of July, 1925.

Observations on the lac insect and its parasites were continued, particular attention being paid to the seasonal appearance of, and extent of parasitization by, *Eublemma amabilis*. Attempts were made to get a parthenogenetic brood of the lac insect. At the instance of the Director of Agriculture, Bengal, the causes of the failure of the lac crop in the Mathurapur Zamindari, Malda District, were investigated. There has been a steady decline in lac production on the estate and the income has fallen from a lakh and a half to about forty thousand rupees. Defective systems of propagation and collection, depletion of healthy brood-lac, and the system of leasing the produce of the estate to contractors have been the main causes of this failure, and erosion of a part of the estate containing large healthy trees has added to it. Recommendations to remedy the evils have been made, and the manager has been advised to obtain the services of a trained man.

The value of lac cultivation is being appreciated and numerous enquiries were received from different parts of India during the year. Demands for the supply of brood-lac could

not be met for want of sufficient number of trees for lac cultivation at Pusa. It is expected that the Indian Lac Association for Research will soon take up the work of maintaining a good supply of brood-lac for distribution. If, however, the work is to remain with the Agricultural Research Institute, it is necessary to start a plantation in some suitable locality and undertake lac cultivation on a larger scale than has been done so far.

V. Insect Survey.

A large number of new species has been added to the collection. Re-arrangement in cabinets was continued. Funds for buying cabinets to accommodate over 8,000 named species represented by over a million specimens are needed. The named collection is being increasingly taken advantage of by the Provincial staffs and other workers on Indian Entomology.

Collections were sent out for identification to various specialists and the help rendered by them is thankfully acknowledged.

The Hymenoptera are in good order. The super-families Formicoidea, Vespoidea, Sphecoidea and Apoidea are very well represented. Bees belonging to the genera *Sphecodes* and *Bombus* were sent to Herrn Blüthgen and Dr. Friese respectively for identification. The former has returned the lot sent to him duly identified.

Practically the whole of the collection of Coleoptera is still contained in store-boxes. During the year all unnamed material in the families Lucanidæ, Cetoniadæ, Melolonthidæ and Erotylidæ was sent to Mr. Arrow for identification and the whole lot has been received back from him duly determined.

Dr. Marshall, Dr. Horn and Mr. Andrewes named Curculionidæ, Cicindelidæ and Carabidæ respectively.

In Lepidoptera, Geometrids were sent to Mr. L. B. Prout, Noctuids to Miss Prout and Micro-lepidoptera to Mr. Meyrick for study. Mr. Prout has kindly returned a major portion

of the collection after identification, and this being valuable material is being now transferred into cabinets.

A small lot of Acrididæ (Orthoptera) collected at Shillong has been sent to Mr. B. P. Uvarov for identification. This has not yet been received.

Further lots of Odonata have been sent to Major Fraser for study.

In Diptera, further lots of Tabanidæ have been sent to Major Austen, Culicidæ to Capt. Barraud and Agromyzidæ to Mr. Malloch.

Scale-insects (Coccidæ) collected mostly from coconut palms in the Andamans have been sent to Mr. E. E. Green, and a species of an Aphid attacking sugarcane to Dr. Vander Goot.

Numerous collections of Indian insects have been received during the year and named as far as possible. These included collections by the Forest Research Institute, the Provincial Departments of Agriculture, the Bombay Natural History Society and numerous correspondents.

VI. Catalogue of Indian Insects.

Satisfactory progress was made in this direction. The following parts of the catalogue have been issued during the year :—

Part 4. Trypetidæ (Trypaneidæ), by R. Senior-White.
,, 5. Nitidulidæ, by S. N. Chatterjee.
,, 7. Lasiocampidæ, by T. Bainbrigge Fletcher.
,, 8. Amatidæ (Syntomidæ), by T. Bainbrigge Fletcher.
,, 9. Zygænidæ, by T. Bainbrigge Fletcher.

Part 6—Staphylinidæ, by M. Cameron, is now in the press.

In Coleoptera, catalogues of Brenthidæ and Cicindelidæ have been completed and are ready for publication, of Carabidæ, Longicorina, Scolytidæ, Platypodidæ, Bestrychidæ, and Anobiidæ are in course of preparation.

In Diptera, the catalogue of Mycetophilidæ has been written up, and will be sent to the press for publication shortly.

VII. Programme of work for 1925-1926.

Major.

This will follow generally on the lines of work of the current year and will include general investigations of crop pest and especially of the pests of sugarcane, rice and cotton, of fruit-trees, and stored grain, and also work on insect pests of domestic animals.

Minor.

Results in various lines require to be written up and published as far as possible. Work and experiments in Lac-culture will be continued and new insecticides and insecticidal methods tested as occasion arises. Systematic work will be carried out with our resources, and the help of specialist correspondents. The Catalogue of Indian Insects will be proceeded with. Advice and assistance will be given as far as possible to Provincial Departments and to all inquirers on entomological subjects.

VIII. Publications.

The following publications, either prepared by the Pusa staff or founded in whole or in part on material sent from Pusa, have actually been issued during the year ended 30th June, 1925 :—

Blüthgen, P. . . . Beitrage zur Systematik der Bienengattung *Sphecodes*, Latr. (*Deuts. Entom. Zeits*, 1924, pp. 457-516.)

Fletcher, T. Bainbrigge . List of Publications on Indian Entomology, 1923. (*Pusa Bull. No. 155.*)

Fletcher, T. Bainbrigge. . The Importance of Entomology to India. (*Indian Medical Gazette*, pp. 276-277; June 1925.)

Fraser, F. C. . . Notes on Indian Odonata in the Pusa Collection. (*Mem. Dept. Agri. India, Entl. Ser.*, Vol. VIII, pp. 69-87, 2 figs., tt. 9-10 ; August 1924.)

Isaac, P. V. . (1) A practical and simple method of rearing Tabanid larvæ.

(2) The number of moults in Tabanid larvæ.

(3) The life-history of *Tabanus crassus*, Wlk. and the identity of the female of the species.

(*Mem. Dept. Agri. India, Entl. Ser.*, Vol. VIII, pp. 53-62, tt. 5-8; August 1924.)

(4) The head and mouth-parts of the larva of *Tabanus rubidus*, Wied.

(5) The mechanism of suction in the larva of *Tabanus tenens*, Wlk.

(6) The male and female genitalia of *Tabanus tenens*, Wlk.

(7) Notes on the life-history of *Tabanus striatus*, Fb.

(*Mem. Dept. Agri. India, Entl. Ser.*, Vol. VIII, pp. 93-109, figs. 1-7, tt. 11-15; April 1925.)

Patton, W.S., & Senior-White, R. — The oriental species of the genus *Musca*, Linnaeus. (*Rec. Ind. Mus.*, XXVI, 553-577, tt. 29-33, Nov. 1924.)

Sen, S. K. . . — Insects and their relation to the diseases of man, animals, and plants. (*Indian Medical Gazette*, pp. 277-279; June 1925.)

REPORT OF THE IMPERIAL AGRICULTURIST.

(G. S. Henderson, N.D.A., N.D.D.)

I. Charge.

Mr. G. S. Henderson, N.D.A., N.D.D., held charge of the Agricultural Section except for the period from 1st July, 1924, to 23rd October, 1924, when he was on deputation to the Bihar Government as Director of Agriculture. Mr. Wynne Sayer, B.A., Secretary, Sugar Bureau, officiated as Imperial Agriculturist during the absence of Mr. Henderson.

Bhai Arjan Singh, L.Ag., continued as officiating Assistant to Imperial Agriculturist throughout the year.

Mr. L. S. Joseph, G.B.V.C., First Cattle Superintendent, was on leave on average pay, combined with leave on half average pay, from 24th February, 1925, to the end of the year, Mr. S. M. Jamaluddin, Second Cattle Superintendent, officiating.

II. Touring and Advising.

On his return from deputation, the services of Mr. Henderson were asked for, by the Government of Bombay, in connection with a number of problems arising from the construction of the Lloyd barrage in Sind. This is the largest irrigation scheme in the world and though the engineering part of the work has already started, there are a large number of very important agricultural questions to be settled. The Imperial Agriculturist went to Karachi and met the leading engineering and revenue officials.

The Imperial Agriculturist, as a member of the Advisory Standing Committee, was on tour in the Punjab in February in connection with alkali land reclamation work. There are large tracts of "bara" (land with a heavy impenetrable alkali soil) which crop up in the canal irrigated districts and give great concern to the Punjab Government.

The Imperial Agriculturist was asked to go to Assam and advise the Local Government on the adoption of a cattle policy for the province.

He has been asked to take up the Presidentship of the Agricultural Section of the next meeting of the Indian Science Congress in Bombay.

A considerable amount of miscellaneous seed was distributed during the year and a large number of visitors were shown round the Agricultural Section. Letters of advice were issued to enquirers in all parts of India. An interesting letter was received from Sir T. R. J. Ward, late Inspector General of Irrigation to the Government of India, to say that some of the Bulletins of this Section had been found very useful to the engineers on the big irrigation scheme in Ceara, North East Brazil.

III. Training.

Five post-graduate students attended the course of training in general agriculture and cattle-breeding from 3rd February to 31st March, 1925.

IV. Pusa Farm and Cultivation.

The farm area, outside the field-experiment fields, besides giving valuable data on the upkeep of fertility under direct cultivation on a practical scale on modern lines, served to supply grain and fodder to the pedigree dairy herd. The farm supports nearly 500 stock. The total area was divided as follows :—

(*a*) 413 acres, unirrigated, worked under a general rotation of which only 200 acres are not liable to be flooded,

(*b*) 100 acres, irrigated, solely devoted to green fodder production,

(*c*) 101 acres for field experiments and non-rotational.

The season. Rainfall from June 1924 to May 1925 amounted to 57 inches as against 24·80 inches last year. The regular monsoon started on 20th of June with a fall of 0·58 inch and 0·77 inch on the following day which enabled the *kharif* sow-

ings to be taken in hand. There was very heavy rainfall in July, August and September, and consequently the *kharif* maize crop was extremely poor as it got no chance of intercultivation. October was dry and enabled a good start to be made for *rabi* preparation. 2·21 inches of rain in November, although it made the *rabi* sowings late, proved extremely useful for the oats already sown. Rainfall figures are given below :—

1924	Rainfall in inches
June	4·72
July	20·86
August	8·09
September	17·38
October	0·53
November	2·21
December	nil
1925	
January	0·66
February	nil
March	nil
April	1·35
May	1·20
TOTAL	57·00

Farm crops during the year. The chief crops were maize in *kharif*, *arhar* (*Cajanus indicus*), gram and oats in *rabi*. Maize for cobs had part sown with *meth* (*Phaseolus aconitifolius*) and part mixed with *arhar* which stood as *rabi* crop after the maize was cut. The maize for grain did not yield as well as usual owing to the plants being beaten down by heavy rain. The best yield of maize was $10\frac{1}{2}$ mds. grain and 150 mds. green fodder per acre from Bhugrasan field, and that of *meth*, gram and *arhar* was 11 mds., 11 mds. and 13 mds., respectively.

The oat crop all over was above the normal, the best yield being 27 mds. per acre and the average 22 mds. an acre from 262 acres.

Upkeep of fertility. Four hundred and thirteen acres (thirteen fields) were worked under the simple rotation mentioned in previous years' reports. This experiment will give valuable data on the upkeep of fertility on a practical scale if carried out continuously for a number of years. Comparative outturn figures from 1912-13 to 1924-25 are given in the following statement :—

TABLE I.

Yield from 13 fields (413 acres) for the last 13 years.

Year	Annual rainfall	Oats and other cereals	Maize	Pulses	Total grain	Green stuff for fodder and silage
	Inches	Mds.	Mds.	Mds.	Mds.	Mds.
1912-13 . .	41·26	2,210	522	894	3,626	16,301
1913-14 . .	61·74	1,997	200	1,100	3,297	11,513
1914-15 . .	54·88	1,749	534	704	2,987	14,427
1915-16 . .	51·37	2,669	884	701	4,254	36,903
1916-17 . .	59·67	2,897	670	932	4,499	31,971
1917-18 . .	45·54	2,376	1,276	1,010	4,662	30,893
1918-19 . .	60·19	3,386	559	1,037	4,982	30,735
1919-20 . .	32·73	2,479	1,064	719	4,262	31,624
1920-21 . .	44·33	2,542	766	1,073	4,381	33,359
1921-22 . .	39·82	3,754	1,267	1,132	6,153	34,492
1922-23 . .	65·78	3,752	496	941	5,189	23,021
1923-24 . .	24·88	2,448	988	1,100	4,536	29,146
1924-25 . .	57·00	5,816	467	1,234	7,517	20,936

V. Field Experiments.

The permanent manurial and rotation plots were continued as before. The outturn figures with details are given below :—

Table II.

Results of permanent manurial plots for the year 1924-25.

Plot No.	Treatment	A Series			B Series		
		Maize grain in lb. per acre	Arhar grain in lb. per acre	Barley grain in lb. per acre	Maize grain in lb. per acre	Oats grain in lb. per acre	Peas grain in lb. per acre
1	No manure	269	815	..	368	579	..
2	Farmyard manure to supply 10 lb. nitrogen per acre	425	1,039	..	572	727	..
3	Farmyard manure to supply 20 lb. nitrogen per acre	502	1,115	..	647	866	..
4	Farmyard manure to supply 30 lb. nitrogen per acre	537	948	..	718	1,020	..
5	Rape cake to supply 20 lb. nitrogen per acre	335	1,014	..	550	661	..
6	Sulphate of ammonia to supply 20 lb. nitrogen per acre	187	961	..	396	482	..
7	Sulphate of potash to supply K_2O as in farmyard manure 3	296	764	..	385	441	..
8	Superphosphate to supply P_2O_5 as in farmyard manure 3	458	700	..	666	883	..
9	Sulphate of potash to supply K_2O and superphosphate to supply P_2O_5 as in farmyard manure 3	426	675	..	454	669	..
10	Sulphate of ammonia to supply nitrogen, sulphate of potash to supply K_2O and superphosphate to supply P_2O_5 as in farmyard manure 3.	356	628	..	665	1,201	..
11	No manure or leguminous crop .	198	..	478	310	482	..
12	Green manure in a cereal rotation	509	..	484	..	776	..
13	Deep-rooted leguminous crop in a cereal rotation	356	774	..	323	636	..
14	One deep and one shallow rooted leguminous crop in the rotation	428	277	..	338	636	48
15	Leguminous crop and green manure in the rotation	914	813	..	..	948	..
16	Green manure and superphosphate to supply P_2O_5 as in farmyard manure 3	1,345	1,308	..	..	2,215	..

The following experiments were carried out under the directions of the Imperial Mycologist to deal with the wilt disease of the *arhar* plant :—

Table III.

(*a*) *Permanent manurial plots in North Pangarbi.*

Plot No.	Treatment	A Series		B Series	
		Maize grain per acre in lb.	Arhar grain per acre in lb.	Maize grain per acre in lb.	Arhar grain per acre in lb.
1	Check (superphosphate)—P_2O_5 60 lb. per acre	154	431	811	647
2	Superphosphate—P_2O_5 20 lb. per acre.	246	318	914	852
3	Check (superphosphate)—P_2O_5 60 lb. per acre.	205	503	626	1,150
4	$MgSO_4$ (magnesium sulphate) 150 lb. per acre ; check (superphosphate)—P_2O_5 60 lb. per acre.	308	698	606	873
5	Check (superphosphate)—P_2O_5 60 lb. per acre.	277	862	411	1,150
6	$MgSO_4$ 300 lb. per acre ; superphosphate—P_2O_5 60 lb. per acre.	205	893	421	1,016
7	Check (bonemeal)—P_2O_5 60 lb. per acre.	113	811	523	688
8	$Fe_2(SO_4)_3$ (ferric sulphate) 150 lb. per acre ; superphosphate —P_2O_5 60 lb. per acre.	246	739	493	821
9	Check (superphosphate)—P_2O_5 60 lb. per acre.	133	801	390	667
10	$Fe_2(SO_4)_3$ (ferric sulphate) 150 lb. per acre ; superphosphate —P_2O_5 60 lb. per acre.	246	606	575	1,027
11	Check (superphosphate)—P_2O_5 60 lb. per acre.	103	411	482	893
12	$Fe_2(SO_4)_3$ (ferric sulphate) 60 lb. per acre ; superphosphate —P_2O_5 60 lb. per acre.	62	534	544	739
13	Check (superphosphate)—P_2O_5 60 lb. per acre.	82	452	431	606

TABLE III—*concld.*

(*b*) *Four plots in Punjab field, B Block.*

No. of plot	Treatment	Outturn per acre in lb.
1 B	No manure	1,137
2 B	4 cwt. superphosphate per acre	2,166
7 B	No manure	1,273
8 B	4 cwt. superphosphate per acre	1,872

Green manure experiments for the Imperial Agricultural Chemist were continued with the following details :—

No. of plot	Treatment	Outturn per acre in lb.
1	No manure	1,032
2	Green manure alone	1,894
3	Superphosphate—50 lb. P_2O_5 per acre	1,540
4	Green manure and superphosphate—50 lb. P_2O_5 per acre	2,140
5	No manure	939
6	No manure	1,309

Leguminous pulses. These common pulses were again tried with the following results :—

Name of pulse	Green fodder per acre in lb.
Meth (*Phaseolus aconitifolius*)	14,025
Velvet beans (*Stizolobium cinereum*)	14,016
Cow-peas (*Vigna catjang*)	10,573
Urid (*Phaseolus radiatus*)	10,648
Guar (*Cyamopsis psoralioides*)	9,239
Soy beans (*Glycine hispida*)	7,528

Meth, guar and cow-peas have been included in the general rotation and are good for grazing during the monsoon.

SILAGE MAKING WITH MAIZE. ABOUT 25,000 MAUNDS OF MAIZE ARE USED EACH YEAR FOR SILAGE.

Val (*Dolichos lablab*) was grown on a large scale as mentioned in last year's report. Although it produced large quantity of green stuff after plucking pods for grain, yet it was not liked by the milk cattle. The work cattle took it when given chopped up.

There is a gap in the green fodder supply in the month of November when the cattle do not get any grazing, and the milk yield goes down considerably and takes a long time to come up. To fill this gap, there are two crops in view (*i.e.*, *val* and soy bean). As regards *val*, it is found that it does not grow rapidly enough for grazing as its sowing time (middle of September) is rather late. Soy bean is also a low yielder but better than *val*, and it stands green till the end of November. An area of 35 acres has been grown with this crop in order to put the cattle on it in the month of November.

VI. Crop Trials.

Trials with imported oats. Scotch "Potato" oat, which is an imported variety, promises to give good results. During the year under report it yielded at the rate of $5\frac{1}{2}$ mds. per acre on a small plot of land. Its growth is very heavy but late in ripening, so liable to be damaged by early west winds. The dry straw is so soft that cattle eat it greedily without chopping or making fine *bhusa*. It is proposed to grow it on a field scale both on irrigated and unirrigated land. Oats are an important crop in Bihar, but the local variety is a small-kernelled and shallow-rooted plant. Bihar oats have been sent to Scotland to be grown for several years to see if these faults would tend to alter in a new environment.

Berseem cultivation. About 15 acres of waste, flooded land were cleared and levelled during the year and added to the irrigated area, making a total of 115 acres. Ninety two acres were sown early with maize which was ready for use in the last week of April for the supply of green fodder. After supplying full pasturage for the herd during May and June, 13,970 mds. green maize was cut for feeding in the byres and for making silage. The land was completely under water in July, August and September, and berseem sowing started on

8th of October when a number of plots were sown by broadcasting seed in standing water after the flood subsided, without any cultivation. The regular sowing commenced in the middle of October. The total area under berseem was 96 acres. Cattle were put on the crop on 21st November and 3 to 4 cuts and grazings were taken. After meeting the full requirements of grazing till end of May 1925, 12,093 mds. green berseem was available for feeding in the byres. The total number of cattle was fed for six months, starting from December, on berseem alone with addition of a little dry *bhusa*. Surplus stuff from grazing and cutting was turned into hay, of which about a thousand maunds was stored for feeding during the rainy season.

The berseem crop was the outstanding feature of the farm cultivation during the year. It presented an unbroken stretch of magnificent clover nearly a mile long in which the milk stock stood knee-deep. The acclimatization of this foreign crop in India is a valuable achievement for the Agricultural Department. It represents a factor of the greatest value for the future improvement of dairying and cattle-breeding in India.

Some plots were kept for seed and about 20 lb. of seed were threshed out.

As mentioned in last year's report, there is no pasture ground and cattle are therefore grazed on cultivated fodder crops. Besides the grazing throughout the year, about half a lakh of maunds of green fodder was cut and fed to the stock ; half the amount was cut from the irrigated area.

Seed selection. The staple farm crops are now grown from specially selected farm seed and a considerable improvement in the quality of the output is now noticeable.

The farm oats are in considerable demand in all parts of India. There are three chief maize selections which now grow pure to type.

One or two heavy yielding strains of chillies have been isolated.

Minor trials. A collection of soy bean and cow-peas is under observation. *Juar* (*Andropogon Sorghum*), chillies and

arhar selections have been made and are under observation. A large collection of fodder grasses was obtained from America. One of these is Bermuda grass which was found to be ordinary Indian *dubh* (*Cynodon dactylon*) grass. So far there is nothing outstanding to report on any of the plants. The *rabi* grains and selections of peas and mustard were tried, and among the wheats Federation from Australia gave the largest output on $\frac{1}{16}$th acre plots.

VII. Machinery.

The steam ploughing tackle consisting of a double set of Fowler's engine worked during the year for 87 days of 10 actual working hours. Working costs and analysis for different operations are shown in the following statements :—

TABLE IV.

Showing cost of working steam tackle for last five years.

Particulars	1920-21. No. of working days 131	1921-22. No. of working days 114	1922-23. No. of working days 112	1923-24. No. of working days 120	1924-25. No. of working days 87
	Rs.	Rs.	Rs.	Rs.	Rs.
Labour	1,450	1,243	1,278	1,317	974
Fuel	2,140	1,622	1,464	1,819	1,498
Oil	588	412	483	486	410
Miscellaneous stores, etc. and renewals	1,764	1,783	2,137	611	1,048
TOTAL	5,942	5,060	5,362	4,233	3,930

TABLE V.

Showing the above cost divided into different operations per acre for the last five years.

Particulars	1920-21			1921-22			1922-23			1923-24			1924-25		
	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year	Cost per acre	Best day's work	Total area cultivated in the year.	Cost per acre	Best day's work
	Acres	Rs.	Acres	Acres	Rs.	Acres	Acres	Rs.	Acres	Acres	Rs.	Acres	Acres	Rs.	Acres
Ploughing	445	6·0	7·5	241·5	5·6	7·8	373·0	5·51	8·34	374·0	4·99	7·06	359·25	4·76	9·5
Disc harrowing	633	2·5	17·5	442·0	2·6	16·5	470·0	2·81	16·50	534·5	2·43	14·46	323·75	3·27	13·8
Grubbing	480	2·0	23·0	600·5	2·0	21·3	507·0	2·25	21·00	494·0	1·80	19·55	320·00	2·47	18·3
Rolling	386	1·8	25·0	285·0	2·0	21·0	333·5	2·06	23·00	127·5	1·45	24·28	165·50	2·21	20·4
TOTAL	1,944	..	..	1,569·0	..	..	1,683·5	..	..	1,530·0	..	..	1,168·50	..	..

Austin and Fordson tractors were used on the farm for lighter operations during the busy time only. They were also used in belt pully work for chopping green fodder, etc. The International silage cutters were extensively used for cutting green stuff (maize, *juar*, etc.) for silage as well as for fodder cutting.

A number of new implements were tried and work is being carried out on wheat threshing machinery design and silage cutting machinery.

The problem of a suitable plant for threshing wheat is one of the very important questions before the Agricultural Department of India. It is getting more and more pressing with the extension of the large wheat areas in irrigated canal colonies.

VIII. Pedigree Milk Herd.

There are a number of interesting facts to record during the year under report.

In March 1925, when the berseem crop was at its best the average yield per head per day of the cows in milk went over 18 lb. This figure is considerably higher than anything ever obtained before. This is the average of 78 cows.

The chief data obtained during the year are along the following lines of investigation :—

Bacteriological work on milk samples. Mr. Walton, Assistant Bacteriologist, published a Bulletin on the result of his investigations. The results showed that a very high class of milk was being produced without either pasteurization or cooling.

Several modifications of the current practice in milk handling were adopted to ensure an even better sample of milk produced under as hygienic circumstances as possible.

The influence of the sire on milk production has been studied from the records of the herd. The following table shows the result of the influence of a good and prepotent Sahiwal bull Prayagi and of a bad bull Himmat. The results are of very great significance. The bull is more than half the herd. A good bull can grade up a bad herd, but a bad bull gives bad milkers even out of good cows.

Table VI.

Influence of good sire Prayagi.

Name and No. of cow.	Best lactation lb.	Name and No. of dam	Dam's best lactation lb.	Increase or decrease in milk yield lb.
1. Ashrafi 211	4,670	Panji 39	4,665	+5
2. Chakli 203	4,317	Padmini 56	4,094	+223
3. Akli 231	5,046	Raseeli 132	4,812	+234
4. Jamali 237	4,420	Divali 77	3,827	+593
5. Deoki 213	5,349	Gomti 75	3,346	+2,003
6. Chabili 187	4,729	Rami 78	3,764	+965
7. Parbati 245	4,037	Rajni 76	4,867	—830
8. Gopi 219	5,121	Foorsi 103	320	+4,801
9. Soonehari 248	4,223	Makhni 28	4,407	—184
10. Kadambari 243	6,347	Jardi 47	4,979	+1,368
11. Abadi 238	4,624	Durgavati 136	3,139	+1,485

Influence of bad sire Himmat.

1. Hanumati 399	4,848	Kaveri 133	4,786	+62
2. Himmati 348	1,728	Gomti 75	3,346	—1,618
3. Goli 305	410	Mootki 122	3,435	—3,025
4. Hasni 339	2,620	Imani 138	6,200	—3,580
5. Halia 393	1,619	Imani 138	6,200	—4,581
6. Rati 358	1,445	Dhoonki 181	3,240	—1,795
7. Haldi 379	3,064	Chakli 203	4,317	—1,253
8. Hundi 383	3,624	Kapurni 283	3,195	+429
9. Hathia 386	1,324	Radhia 279	3,520	—2,196
10. Hisli 353	675	Thakrani 250	3,923	—3,248

Cross-breeding. It is now possible to draw preliminary conclusions from the work of crossing the cross-bred Ayrshire and Montgomery cattle among themselves. At present it would seem that after the first generation the results are not hopeful. The half-bred cow is almost always a good animal but the progeny are poor on the whole.

General. The strength of the herd at the end of year stood at 372 animals. The health of the herd was good throughout the year.

AYRSHIRE BULL "VICTORY BOND."

AYRSHIRE × SAHIWAL COW "ALIBI" HAS EXCEEDED 12,000 lb. MILK IN 10 MONTHS.

PLATE III.

The uninoculated portion of the herd was inoculated against rinderpest by the simultaneous method. The pedigree Ayrshire bull died of piroplasmosis.

A number of alterations, as stated above, have been made in the dairy practice during the year with a view of obtaining a purer milk. Buildings have been re-designed and changes made in feeding and grazing. At the end of the season motor vans were started for conveying milk not required in Pusa to the city of Muzafferpur, 22 miles distant. It is readily sold and will lead to a considerable increase in the revenue. About 300 lb. of milk per day is now being sold there from a shop opened in the bazaar. The supply of pure milk is greatly appreciated in the Muzafferpur city.

Yield of milk. It will be seen from the following table that $4\frac{1}{2}$ lakhs lb. of milk were produced as against $3\frac{4}{5}$ lakhs lb. in the previous year, and that the average figure of yield per cow per day has increased to 14·4 lb. which is nearly one and a half gallons per cow—a result which will compare well with good dairy herds in any part of the world.

TABLE VII.

The milk yield of Pusa Herd for 1924-25.

Month	ACTUAL YIELD			AVERAGE YIELD PER DAY PER COW					
				CROSS-BRED COWS		MONTGOMERY COWS		TOTAL	
	Cross-bred cows	Montgomery cows	TOTAL	Average per day	Average per cow per day	Average per day	Average per cow per day	Average per day	Average per cow per day
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
July 1924	19,123	19,237	38,360	617	16·6	621	11·6	1,237	13·6
August „	16,981	17,378	34,359	548	15·6	561	11·0	1,108	12·8
September „	18,247	15,867	34,114	608	14·5	529	10·3	1,137	12·2
October „	16,975	15,475	32,450	548	13·7	499	9·7	1,047	11·6
November „	19,902	11,895	31,797	663	14·1	396	9·0	1,060	11·7
December „	23,348	13,569	36,917	753	15·3	438	9·3	1,190	12·4
January 1925	24,651	13,342	37,993	795	18·1	430	10·2	1,225	14·2
February „	23,205	13,855	37,060	828	18·4	495	11·2	1,324	14·8
March „	28,960	14,747	43,707	934	21·7	476	13·6	1,410	18·0
April „	28,170	14,684	42,854	939	19·5	489	13·2	1,428	16·8
May „	27,528	15,170	42,698	888	17·7	489	12·5	1,377	15·4
June „	24,719	13,933	38,652	824	17·5	464	12·2	1,288	15·1
Yield for 1924-25	2,71,809	1,79,152	4,50,961	745	16·8	490	11·1	1,236	14·4
Yield for 1923-24	2,09,763	1,76,808	3,87,371	573	15·6	482	10·7	1,055	12·9

Individual milk yields. In the Sahiwal section of the herd 14 cows have given over 5,000 lb., and of these six have given over 6,000 lb. of milk in one lactation. Excepting heifers and cows under trial and one and a half dozen cows of good constitution kept for cross-breeding with the Ayrshire bull, all the Sahiwal cows have given over 4,000 lb. in 10 months.

Among the half-bred Ayrshire and Sahiwal cows 17 have given over 6,000 lb., and very shortly it is expected that three cows will exceed the 10,000 lb. mark.

Among the miscellaneous crosses a large number of rejections have been found necessary. Five cows have gone a little over 4,000 lb.

Financial return. The total return from the sale of milk and milk productions amounted to Rs. 24,460 as against Rs. 22,192 in the preceding year. In the coming year the return will be considerably increased owing to sale of milk in Muzafferpur.

One hundred and twenty-nine animals were disposed of from the herd during the year, realizing over Rs. 5,000. The best price obtained was Rs. 500 each for two young Sahiwal bulls. A large number of young cattle were sold off at nominal prices when the monsoon crops were found to be poor and there seemed to be a danger of fodder shortage. Also a number of the double-cross animals proved to be very poor and were cleared out at a nominal price (Appendix II).

A gross return of nearly Rs. 30,000 from the year's working is very satisfactory in view of the large amount of costly experiment work which is undertaken.

Percentage of cows in milk. A very important point on which little data exists in India, is the percentage of cows in the herd which are in milk at any one time. This is all the more important when fresh milk is being sold. It is one of the difficulties of dairying in India that Indian cows will not calve regularly.

TABLE VIII.

Percentage of cows in milk and dry in Pusa Herd, 1924-25.

Month	CROSS-BRED COWS				MONTGOMERY COWS				TOTAL OF CROSS-BRED & MONTGOMERY COWS			
	Total No. of cows	In milk	Dry	Percentage in milk	Total No. of cows	In milk	Dry	Percentage in milk	Total No. of cows	In milk	Dry	Percentage in milk
July 1924 . . .	62	37	25	60·0	94	54	40	57·4	156	91	65	58·3
August „ . . .	61	35	26	57·3	95	51	44	53·6	156	86	70	55·1
September „ . . .	61	42	19	68·8	96	51	45	53·1	157	93	64	59·2
October „ . . .	67	40	27	59·7	95	51	44	53·6	162	91	71	56·1
November „ . . .	67	47	20	70·1	97	44	53	45·4	164	91	73	55·5
December „ . . .	63	49	14	77·7	95	47	48	50·0	158	96	62	60·7
January 1925 . . .	60	44	16	73·3	92	42	50	45·6	152	86	66	56·5
February „ . . .	62	45	17	72·5	95	44	51	46·3	157	89	68	56·7
March . „ . . .	62	43	19	69·3	91	35	56	38·4	153	78	75	51·0
April . „ . . .	64	48	16	75·0	81	37	44	45·6	145	85	60	58·6
May . „ . . .	64	50	14	78·1	81	39	42	48·1	145	89	56	61·3
June . „ . . .	64	47	17	73·4	82	38	44	46·3	146	85	61	58·2
Average per month during 1924-25.	63	44	19	70	91	44	47	49	154	88	66	57·3
Average per month during 1923-24.	53	37	16	70	89	45	44	50	142	82	60	57·4

IX. Programme of work for 1925-26.

1. (*a*) Practical treatment of pedigree dairy herd of Indian cattle and pedigree dairy herd of Montgomery-Ayrshire cattle.

(*b*) Continuance of experiments with regard to fixing a type of Montgomery-Ayrshire most suitable to Indian conditions.

2. Practical treatment of a 1,200-acre mixed farm with particular attention to profitable modern machinery and the financial results of the work.

The bulk of the produce of the Pusa Farm is used for the maintenance of the dairy herd. The rotation adopted aims at the upkeep of the fertility of the land along with supply of concentrated food and long fodder and a constant supply of green fodder throughout the year. Included in the above is the study on a practical scale of :—

(*a*) Rotations.
(*b*) Crops for fodder, seed and silage.
(*c*) Implements and machinery.
(*d*) Technique of cultural operations.

3. Continuation of collection of data and results regarding the costs and capabilities of the steam-ploughing tackle on estates of this size.

4. Experiments with various types of motor tractors and ploughs for collection of data and working costs and for determination of most suitable types of tractors and implements for India. Also collaboration with manufacturers regarding the manufacturing and introduction of improvements in standard types to suit Indian conditions.

5. *Experimental work at Pusa.*

(*a*) Rotational experiments.
(*b*) Trial of new varieties of crops, especially leguminous fodder crops and wheat varieties.
(*c*) Manurial experiments, especially seasonal and quantitative tests with phosphates.
(*d*) Trial of sugarcane varieties suitable for growth without irrigation, along with the Sugar Bureau.

6. Demonstrations, exhibitions and sales of surplus dairy stock, etc., will be held from time to time as occasion offers.

7. *Touring and Advisory.* Visits will be paid to provincial agricultural centres.

Appendix I.

List of cows of the Pusa Herd which completed their lactation during 1924-1925.

Serial No.	Name and No. of cow	Date of birth	Number of calvings	Quantity of milk (lb.) given during the year (days)
	I. Montgomery Cows (Heifers excluded).			
1	Kadambari 243	10-1-14	5	6,347 (296)
2	Anamati 269	25-12-14	4	6,257 (305)
3	Sita 330	30-8-17	3	6,011 (306)
4	Kamli 312	7-11-16	4	5,848 (304)
5	Kabutri 236	29-9-13	4	5,727 (305)
6	Deoki 213	14-12-12	5	5,349 (305)
7	Tutia 318	5-2-17	4	5,252 (296)
8	Sampati 311	31-10-16	3	5,213 (306)
9	Gopi 219	16-3-13	5	5,121 (307)
10	Godavari 315	21-1-17	4	5,022 (305)
11	Milapi 263	11-11-14	4	4,897 (305)
12	Mundri 389	11-8-19	2	4,868 (304)
13	Hanumati 399	10-2-20	2	4,848 (304)
14	Garbee 300	5-4-16	4	4,770 (302)
15	Akli 231	19-7-13	6	4,590 (303)
16	Dhukhni 325	10-3-17	4	4,563 (276)
17	Bhagti 369	25-10-18	3	4,418 (305)
18	Mina 338	17-11-17	3	4,334 (307)
19	Mania 388	4-7-19	2	4,287 (306)
20	Anjani 210	24-11-12	7	4,199 (304)
21	Abadi 238.	16-10-13	5	4,178 (293)
22	Tara 337	15-11-17	3	4,103 (269)
23	Lotni 327	31-3-17	4	3,868 (279)
24	Munssari 257	14-9-14	5	3,449 (238)
25	Gangia 317	27-1-17	3	3,166 (261)
26	Soonehari 248	16-4-14	5	3,108 (235)
27	Rookmini 332	30-9-17	3	2,323 (287)
	II. Half-bred Ayrshire-Sahiwal Cows.			
1	Kitty 10	22-5-16	6	8,104 (305)
2	Patty 8	19-3-16	6	7,946 (305)

List of cows of the Pusa Herd which completed their lactation during 1924-1925—contd.

Serial No.	Name and No. of cow	Date of birth	Number of calvings	Quantity of milk (lb.) given during the year (days)
	II. Half-bred Ayrshire-Sahiwal Cows—*concld.*			
3	Glory 22	14-2-17	4	7,483 (304)
4	Bella 23	3-3-17	5	6,869 (304)
5	Aggie 19	8-1-17	4	6,456 (304)
6	Nelly 13	27-10-16	5	6,445 (270)
7	Maudie 40	16-6-18	3	6,421 (305)
8	Dollie 20	9-1-17	6	6,415 (295)
9	Fanny 21	11-2-17	5	6,227 (306)
10	May 29	3-8-17	4	5,947 (225)
11	Anne 16	20-12-16	5	5,904 (287)
12	Pierette 36	2-12-17	4	5,887 (307)
13	Polly 18	4-1-17	4	5,765 (304)
14	Peggy 9	16-4-16	6	5,746 (304)
15	Lassie 65	24-11-19	2	5,544 (304)
16	Sallie 26	14-4-17	5	5,490 (304)
17	Pansy 4	10-3-15	7	5,240 (304)
18	Cynthie 35	9-11-17	4	5,003 (286)
19	Jess 59	6-3-19	3	4,978 (276)
20	Leonora 45	7-10-18	3	4,591 (305)
21	Esmie 33	27-10-17	4	4,179 (241)
22	Nora 42	8-9-18	3	3,708 (281)
23	Clara 63	11-11-19	2	3,661 (304)
	III. Half-bred Ayrshire-Sahiwal Heifers.			
1	Laura 98	9-8-21	1	6,685 (304)
2	Lily 103	10-9-21	1	6,066 (304)
3	Lena 81	2-11-20	1	5,461 (305)
4	Liela 99	10-8-21	1	4,368 (304)
5	Lizta 101	27-8-21	1	4,321 (304)
6	Lettie 97	25-7-21	1	4,280 (291)
7	Liza 100	16-8-21	1	3,942 (304)
8	Lottie 91	4-4-21	1	2,692 (234)
9	Cora 79	21-8-20	1	2,677 (242)
	IV. Miscellaneous Ayrshire-Sahiwal Crosses.			
1	Beula 70	5-3-20	1	4,672 (305)
2	Bessie 56	5-2-19	2	4,533 (307)
3	Selina 54	9-1-19	3	4,428 (304)

List of cows of the Pusa Herd which completed their lactation during 1924-1925—concld.

Serial No.	Name and No. of cow	Date of birth	Number of calvings	Quantity of milk (lb.) given during the year (days)
	IV. Miscellaneous Ayrshire-Sahiwal Crosses—*concld.*			
4	Flo 32	22-10-17	3	4,179 (305)
5	Mercy 74	31-3-20	1	4,055 (305)
6	Barbara 89	23-3-21	1	3,298 (306)
7	Bee 68	5-2-20	2	1,779 (196)
	V. Poor milking Sahiwal Cows kept for crossing with Ayrshire bull.			
1	Mahajani 349	14-2-18	4	3,585 (215)
2	Ganika 345	..	3	3,121 (304)
3	Shanti 329	17-4-17	3	2,973 (305)
4	Boondi 402	30-3-20	2	2,672 (304)
5	Hasni 339	8-12-17	2	2,620 (221)
6	Nasoorti 427	8-3-21	1	2,517 (295)
7	Bhagni 340	8-12-17	3	2,516 (247)
8	Runia 281	3-8-15	5	2,455 (201)
9	Nari 381	27-4-19	2	2,230 (269)
10	Ahilya 331	29-9-17	3	2,169 (260)
11	Hundi 383	12-5-19	3	2,104 (156)
12	Manorma 432	16-5-21	1	2,070 (217)
13	Nandini 423	29-1-21	1	1,849 (304)
14	Hirni 302	15-4-16	5	1,638 (130)
15	Maheshari 420	13-1-21	1	1,577 (210)
16	Bimla 382	11-5-19	4	1,547 (108)
17	Keerti 352	18-5-18	3	1,521 (240)
18	Haldi 379	16-3-19	3	1,351 (119)
19	Mithi 419	7-12-20	1	1,278 (294)
20	Mainka 436	27-8-21	1	1,273 (190)
21	Mahila 417	26-11-20	2	1,228 (124)
22	Maya 359	27-6-18	4	1,129 (95)
23	Sushila 365	23-9-18	3	1,085 (127)
24	Maheru 429	16-3-21	1	1,035 (118)
	VI. Old Sahiwal Cows.			
1	Imani 138	27-8-10	7	2,879 (288)
2	Mungli 108	14-11-09	10	1,445 (182)
3	Begmi 107	2-10-09	10	416 (64)

Appendix II.

List of cattle sold from the Pusa Herd during 1924-1925 with their prices.

Serial No.	Particulars	Amount	Remarks
		Rs.	
	Sahiwal cow—		
1	Nidia	40	Rejected cow.
2	Lakhia	25	Do.
3	Fahmi	40	Do.
4	Kakai	40	Do.
5	Churamani	40	Do.
6	Mandodari	40	Do.
7	Hinmati	80	Poor milker.
8	Halia	80	Do.
9	Kalia	80	Do.
10	Rati	80	Do.
11	Nathuni	74	Do.
12	Bali	53	Do.
13	Sundri	50	Do.
14	Mainy	50	Do.
15	Ladli	41	Do.
16	Balika	52	Do
17	Apsara	52	Do.
18	Damini	40	Barren cow.
19	Hisli	100	Poor milker.
20	Nasi	12	Barren cow.
	½-bred cow—		
21	Joan	100	Low yielder.
22	Mary	150	Do.
23	Molly	50	Heart symptoms.

List of cattle sold from the Pusa Herd during 1924-1925 with their prices—contd.

Serial No.	Particulars	Amount	Remarks
		Rs.	
	½-bred cow—		
24	Leslie	50	Poor milker.
25	Caro	80	Do.
	¼-bred cow—		
26	Ida	50	Do.
27	Poppy	40	Do.
28	¾-bred cow Thora	75	Do.
	D. C. cow—		
29	Lizzy	75	Do.
30	Barney	50	Do.
31	Bapsy	15	Disease suspected.
32	Blanche	15	Do.
33	Bridget	50	Poor milker.
34	Bertha	50	Do.
35	Maggie	50	Do.
36	Beatrix	50	Do.
37	Girty	33	Do.
	Sahiwal young bull No.—		
38	371	70	Sold young, scarcity of fodder
39	380	45	Do.
40	360	500	First class young bull
41	361	500	Do.
42	362	150	Good bull yearling.
43	363	150	Do.
44	369	100	Do.
45	373	50	Sold young.
46	374	50	Do.

List of cattle sold from the Pusa Herd during 1924-1925 with their prices—concld.

Serial No.	Particulars	Amount	Remarks
	Sahiwal young bull No.—	Rs.	
47	375	50	Sold young.
48	377	70	Do.
49	370	100	Do.
	Sahiwal heifer No.—		
50	392	50	Do.
51	364	50	Do
	D. C. heifer No.—		
52	78	50	Do.
53	69	45	Do.
54	½-bred bull Arta Xiexes	200	
55-73	19 rejected Sahiwal bull-calves	560	
74-95	22 rejected cross-bred bull-calves	71½	Sold at birth, unsuitable for rearing.
96-115	20 rejected cross-bred cow-calves	211½	Do.
116-127	12 cross-bred bull-calves	Free	Given to Imperial Institute of Veterinary Research, Muktesar.
128	Sahiwal cow Rajni	Free	Samastipore Pinjrapole.
129	Cross-bred cow-calf of Milapi		
	Total	5,125	

REPORT OF THE IMPERIAL DAIRY EXPERT.

(William Smith.)

I. Introduction.

Mr. E. J. Bruen held charge of the office of Imperial Dairy Expert from 1st July to 8th November, 1924. I took over charge from Mr. Bruen on 9th November, 1924, on my return from leave.

There is no doubt but that the importance of the cattle-breeding and dairy industry from the agricultural and national points of view is becoming more and more accepted in India by the Governments responsible for the development of the country, and by the educated classes. Even the politicians are calling attention to the importance of providing a pure milk supply and of breeding efficient cattle. This much needed awakening although moving slowly can be noticed all over the country, and this office has throughout the year under review been in active co-operation with the Agricultural Departments of practically all the Provincial Governments, larger Indian States and City Municipal Corporations in the matter of giving advice and assistance in technical matters connected with the dairy and cattle-breeding industry. It is the aim of this Section to keep in the closest possible touch with the progress of animal husbandry and dairying throughout the whole world, and to co-operate in particular with the Agricultural Departments of Local Governments and Indian States, in emphasizing the agricultural importance of this great industry from the point of view of the general development of the country and in furthering this end by such advice and assistance as can be given.

Although this increased interest in these problems is gratifying, it is still a lamentable fact that the cattle-breeding and dairy industry does not occupy the place which its far-reaching importance demands in the work of the Agricultural Departments, nor in the mind of the educated people of the country

directly or indirectly interested in agriculture. This is due mainly to two reasons: firstly, the Indian cultivator is so keenly interested in the production of money crops that he has not so far realized the crying need of Indian agriculture for a system of mixed farming which provides for the rearing of stock and the manuring of his lands; and secondly, the wandering cattle breeders who now provide the working bullock are illiterate and altogether inarticulate. Not only so, but these cattle-breeding tribes are so unstable that the better class of financier will not advance them money, and consequently the financiers who are so deeply interested in jute and wheat and cotton are not likely to raise their voice on behalf of the cattle-breeding and dairy industry. The dairy or milk producing side of the industry is unorganized and inarticulate in that the great mass of those engaged in it are entirely illiterate and sunk in what might be classed as trade superstition. It will, I think, be admitted that the Agricultural Departments of India spend far more time, money and thought on the development of improved types of crops than they do in improving the dairy industry, and yet the improvement of the dairy industry is as important as the improvement of crops. The present backward and deplorable condition of the milk and *ghi* industry strikes at the very root of the health of the community, and the efficiency of the working bullock must always be dependent on the quality of the cow from which he is bred. The work done by this Section as described in this report only touches the fringe of this gigantic problem, for an agricultural country like India cannot possibly be really prosperous until the importance of the cattle-breeding and dairy problem is realized by the people themselves. As soon as articulate public opinion demands it, and not before, will this problem receive the attention which its importance warrants from the State.

II. Training.

Believing that the most valuable aid which this Section can give to the country in the direction of the improvement of the state of affairs above described is the dissemination of knowledge, the fullest possible use has been made of the

facilities available for training students. Throughout the year 13 students for the Indian Dairy Diploma and seven post-graduate students were in residence at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, and the Imperial Cattle-Breeding Farm, Karnal, and some twelve short-course students received instruction on special technical subjects at these two farms. In this connection I desire to express my appreciation of the cordial help and valuable assistance given by Mr. F. J. Warth, Physiological Chemist, and his staff in training students. Mr. Warth's department undertook a great part of the training of the post-graduate students, and the whole of the instruction of all students in chemistry, animal nutrition and allied subjects has been done by him.

Towards the end of the year an enquiry was sent to the Co-operative Departments of all Provincial and Indian State Governments asking whether they considered that technical dairy education of their staffs by this Section would aid in the development of the dairy industry through the establishment of co-operative dairy societies, and as the response to this enquiry shows the need for education of this kind, steps are being taken to provide such facilities, and it is hoped that a special training class for officers of Co-operative Departments will be commenced at the Bangalore and Karnal farms early next year.

In accordance with the practice followed in last year's report the advisory work done may be classed as :—

(*a*) Work done for Local Governments, Indian States, Municipalities, etc.

(*b*) Advice given to the general public in India.

(*c*) Information given to persons or Governments outside India.

III. Work done for Local Governments, Indian States and Municipalities.

Bombay. Mr. Bruen visited Bombay on 23rd July, 1924, to interview the Dairy Expert of the Bombay Municipality in

connection with the dairy schemes for that city, and at the same time he advised the Infants and Public Milk Supply Co. regarding the conditions on which a subsidy would be granted by the Municipal Corporation to companies undertaking to supply milk in Bombay.

Mr. Bruen supplied the Live-stock Expert to the Government of Bombay with a plan showing the arrangement of machinery to be installed in the new dairy school proposed for Poona. The Municipal Secretary of the Bombay Corporation was consulted by Mr. Bruen as to the restrictions to be imposed on the slaughter of prime cattle.

On my return from leave, I had two interviews with the Municipal Commissioner—one on the 7th and another on the 8th November, 1924, and at the Commissioner's request I reviewed the scheme for improving the milk supply of Bombay drawn up by the Dairy Superintendent to the Corporation of Bombay, and advised this officer as to the formation and constitution of the proposed subsidised dairy company in Bombay. I again visited Bombay on 17th November to discuss with the Secretary, Infants and Public Milk Supply Co., the future working of this concern under the proposed municipal subsidy. I was again called upon to visit Bombay on 26th March, 1925, to advise the promoters of the proposed milk supply companies there concerning the conditions under which their concerns will operate, and in company with the promoters I interviewed the Deputy Secretary to the Government of Bombay, Revenue Department, the Municipal Commissioner, and the Dairy Superintendent of the Bombay Corporation. My recommendations for subsidising dairy companies by the Municipality were accepted in January 1925.

A scheme for the control and betterment of the milk supply of Bombay drawn up by the Dairy Superintendent of Bombay Corporation was sent to me for opinion and criticism. The Corporation of Bombay were given the loan of 2 American dairy-cattle-breeding cinema films for use at their baby milk demonstrations, where these films were shown twice daily for a week.

At the request of the Principal, Agricultural College, Poona, I visited Poona on 9th November, 1924, to advise him concerning the erection and equipment of a proposed dairy school in connection with the Poona Agricultural College. While at Poona I examined the building sites suggested for this school, and as a result of this visit a set of suitable building plans, and specifications of the necessary equipment were provided. The Live-stock Expert to the Government of Bombay was supplied with a set of specimen plans for cattle sheds, bull shed, dry and youngstock sheds, calf pens and dairy buildings.

Baroda State. At the request of the Director of Agriculture, Baroda, a note on the conservation of grass in the form of silage and an amended specification of dairy machinery for the Palace Dairy were supplied. At the request of the Dewan of Baroda State, I visited the Cattle-Breeding and Dairy Farm at Makarpura and submitted a report on the working of this concern. The Superintendent of the Palace Dairy and Cattle-Breeding Farm, Baroda, was advised in dairy-cattle-breeding matters from time to time.

Madras. Under orders of the Government of India, Mr. Bruen attended the Valuation Committee held at Hosur on 24th August, 1924, for the purpose of valuing the live-stock taken over by the Madras Agricultural Department from the Hosur Remount Depot. Thirty-one cross-bred heifers were supplied from the Bangalore farm for the cattle farm of the Government of Madras at Hosur.

At the request of the Director of Agriculture, Madras, I attended a conference in Ooty on 15th May, 1925, between the Agricultural Department, Public Health Department, and the Revenue Secretary of Madras Government, in connection with the milk supply of Madras, at which my recommendations concerning the sending of milk by rail to the Madras hospitals were adopted ; trial consignments of milk are now being sent by the Imperial Institute of Animal Husbandry and Dairying, Bangalore, to Madras.

Arrangements have been made for the selection of 12 Scindi cows for the Madras Agricultural Department.

The Deputy Director of Agriculture, Live-stock, Madras, was in correspondence with this office throughout the year on cattle-breeding and dairy matters.

Mysore State. At the request of the Live-stock Expert to the Mysore Government, a set of plans for dairy building and cattle shed was supplied, and at the request of the Director of Agriculture, Mysore, I examined the agriculture students at the Hebbal farm in dairying and cattle-breeding.

Bengal. At the request of the Director of Agriculture, a note showing the profits earned by certain military dairy farms in the Northern Circle was obtained and supplied. He was also advised as to the best design of silo to hold 1,000 mds. silage, and was supplied with an amended trading account for the proposed Government demonstration dairy farm. A set of dairy building plans with estimated cost of same were supplied to the Superintendent of the Rangpur Cattle-Breeding Farm. The Executive Engineer, 2nd Calcutta Division, was supplied with a plan of cattle shed capable of housing 100 cows and 100 calves together with a plan of dairy building suitable for accommodating pasteurizing and refrigerating machinery to deal with up to 5,000 lb. milk daily.

I visited Calcutta on 6th March, 1925, and at the request of the Calcutta Corporation I attended a meeting of their Public Health Committee, and, as a result of this, detailed recommendations for the improvement of Calcutta milk supply were submitted.

I interviewed the Deputy Chairman of the Co-operative Milk Societies Union, Calcutta, on 7th March, 1925, in order to advise them *re* Calcutta milk supply, and as a result of this interview the following information was supplied to this society :—

(1) List of bulls available for sale at Karachi.
(2) Plan of proposed milk depot at Sealdah with a note on cold storage construction.
(3) Specifications of machinery, plant and furnishings and stores.
(4) Estimate of total capital cost.
(5) Statement of working expenses.

Burma. At the request of the Municipal Commissioner, Rangoon, a note showing the area of land in possession of the Bangalore Dairy Institute and its activities was furnished to the Municipality of Rangoon.

The Commanding Royal Engineer, Maymyo, was supplied with a complete set of building plans for the establishment of a proposed station dairy at Maymyo together with specifications for pasteurizing and refrigerating machinery, and a note regarding the working of such a dairy on modern lines.

United Provinces. The Deputy Director of Agriculture in charge of Cattle-Breeding Operations was supplied with a note on the subject of the rations to be fed to calves from birth ; he was also advised as to the best class of refrigerating vans for carriage of milk for long distances and the best type of cattle truck for the carriage of dairy cattle. Arrangements were made for the training of their Farm Overseer, B. Thakurlal, in dairy farming for six months at the Bangalore and Karnal farms.

I visited Allahabad on 27th February, 1925, and inspected the Agricultural Institute at that station where I addressed the Dairy Diploma course students, and made recommendations regarding the training of these students.

Bihar and Orissa. The Director of Agriculture, Bihar and Orissa, was advised with regard to the feeding of calves.

At the request of the Veterinary Adviser to the Government of Bihar and Orissa, I visited Patna on 5th March, 1925, and delivered a lecture at a public meeting, organized by this officer, on the importance of developing the cattle-breeding-dairying industry in India. His Excellency Sir Henry Wheeler, the Governor of this province, presided at this meeting which was attended by many members of the local Legislative Council. Later at the request of the same officer, a complete scheme, with plans and machinery specifications, for the proposed dairy cattle-breeding farm in connection with the State Veterinary College, was supplied. The Director of Agriculture and the Veterinary Adviser to the Government of Bihar and Orissa visited the Karnal farm on 9th April, 1925, and were shown the result of our cattle-breeding operations there.

Arrangements were made for the Veterinary Inspector in-charge of the Shahabad District to visit the Karnal farm to enable him to study our working conditions and particularly the breeding work of Thar-Parkar cattle for dual purpose.

The Assistant Director in charge of the Civil Veterinary Department, Orissa Range, Cuttack, was supplied with a plan and building specifications for a calf pen.

Punjab. Mr. Bruen visited Lahore on 30th July, 1924, in order to inspect the dairy farm of Mrs. Brown's Syndicate, and a report on the working of this farm was submitted to the Director of Agriculture, Punjab.

At the request of the Director of Agriculture, Punjab, I visited Lahore on 24th December, 1924, to discuss with him the cattle-breeding policy to be adopted in the Punjab, and as an outcome of this conference a note on the development of cattle-breeding in the Punjab was furnished. I gave a public lecture illustrated by cinema films during Baby Week in Delhi.

Kashmir State. The Chief Secretary to His Highness General Raja Sir Hari Singh, K.C.I.E., of Kashmir was in correspondence with this office in connection with securing first class cows for the State dairy.

IV. Advice given to the General Public in India.

Messrs. A. and M. Wazir Ali & Co., Army Contractors, were advised as to the best type of cattle for their Regimental Dairy at Secunderabad, and this firm was also furnished with technical advice regarding the manufacture and sale of dairy produce, and sale rates to be charged by them for their dairy produce at Secunderabad.

At the request of the Zamindar of Kangundi (North Arcot), his estate was inspected by the Senior Superintendent of this department in order to advise him regarding the introduction of dairying and cattle-breeding on his estate, and as a result of this visit and subsequent conference with this Zamindar at Bangalore two complete schemes, one for a dairy farm for the supply of milk to Madras, and the other for starting a forest cattle-breeding farm, were supplied.

In addition to the foregoing, specific advice and information on dairying and cattle-breeding matters was supplied to

firms, public bodies and private individuals at Bombay, Kaira, Vizagapatam, Shikarpur, Lahore, Ferozepur, Bangalore, Madras, Nasik, Bharatpur, Meerut, Wellington, Ajmer, Calcutta, Mussoorie, Darjeeling, Agra, Thackady, Taran Taran, Colombo, Murree, Rangoon, Gwalior, Delhi, etc.

V. Information given to Persons or Governments Outside of India.

Mr. J. Rangel, L.Y. Cia, Mexico, was advised as to the best Zebu cattle suitable for importation to Mexico.

The International Agricultural Institute at Rome was supplied with a note descriptive of the present position of the dairy industry in India and of the work done by the Government of India in connection with its development.

A note on the general and outstanding characteristics of Zebu cattle was supplied to the Manager, Government Farms, Buea, Cameroons.

Certain information regarding the Scindi cows asked for by Mr. F. L. Russell of Abyssinia was supplied.

The Director of Animal-Breeding Section of the Agricultural Department of Mexico was supplied with a copy of the paper on the importance of developing the dairy industry in India submitted to the International Dairy Congress, Washington, in 1923.

At the request of the Consulate-General for Siam, Calcutta, arrangements were made for the purchase and shipment of two Hariana cows and one bull to Siam.

At the request of the Director of Agriculture, Madras, the services of a trained and experienced dairy manager were secured for the Director of Agriculture, Sarawak, and arrangements have been made for the shipment of six Scindi cows and one bull to Sarawak.

VI. General.

Eight cross-bred calves were supplied from Bangalore to the Imperial Veterinary Research Institute at Muktesar, also facilities were provided for Mr. V. Krishnamurthi (under

training for the Imperial Veterinary Service) to visit the Bangalore Institute in connection with his study-tour.

At the request of the Agricultural Adviser to the Government of India, a scheme for equipping the Bangalore Institute for teaching butter-making on a factory scale was submitted.

A note outlining the directions in which this Section could be developed was submitted to the Agricultural Adviser.

Photographs depicting the activities of the three farms under the control of this Section were supplied to the Agricultural Adviser for the use of the High Commissioner for India, London.

At the request of the Agricultural Adviser, I visited Pusa on 3rd March, 1925, and discussed with him and the Imperial Agriculturist the future cattle-breeding policy to be followed on the farm attached to that Institute and the steps to be taken to increase the receipts from the sale of milk. As a result of this conference, complete specifications of a milk sterilizing plant, to enable the Pusa farm to sell their milk in Calcutta, were sent to the Imperial Agriculturist.

During the year under review photographs of the principal breeds of cattle in India were collected for the preparation of lantern slides for educational work, and the following were supplied with a copy of most of these slides :—

Professor of Agriculture, Poona.
,, ,, Lyallpur.
,, ,, Cawnpore.
Deputy Director of Agriculture, Mandalay.
,, ,, Cattle-Breeding, Nagpur.
Live-stock Expert to the Government of Mysore.

I visited Delhi on 19th November, 1924, and there discussed with the Hon'ble Member and the Secretary, Education, Health and Lands Department, and the Agricultural Adviser the agenda of the proposed Agricultural Conference and Cattle Conference to be held at Delhi.

At the request of the Secretary, Education, Health and Lands Department, I visited Anand on 27th November, 1924, and there had the privilege of showing Sir B. Narasimha Sarma the buildings, plant and lands in possession of the military dairy factory at that station.

VII. Karnal, Bangalore and Wellington Farms.

Karnal. The development of this farm as a centre for cattle-breeding research work proceeded with some degree of rapidity in the year under review. In accordance with the accepted policy as recommended by the Board of Agriculture at Bangalore in 1924, the foundation stock of a herd of Hariana (Hansi Hissar) cattle were procured partly by transfer of 2 bulls, 8 cows and 8 heifers and young bulls from the Hariana herd of the Military Dairy Farm, Cawnpore, and partly by purchase of 24 specially selected cows of this type in Rohtak. The existing Thar-Parkar herd was increased during the year by the purchase of 14 cows and 2 bulls in Sind; both herds are thriving well in Karnal and should in course of time prove the feasibility of combining first class draught and milk-giving qualities in one and the same breed. For the present all the calves from the two herds are being reared, and consequently at the end of the year under review the herd at this farm had increased to a total of 255. As the size of these herds will continue to increase, it follows that the farm will require to increase the area under fodder crops year by year at the expense of the area devoted to money crops. The general health of the stock at Karnal was good throughout the year, but the farm crops suffered badly from floods in September and October which devastated the whole countryside in that part of the world. The damage done was estimated to be about Rs. 15,000. The students taking the Dairy Diploma course at Bangalore spent three months at Karnal and were during that time given specific instruction in crop cultivation, general farm management, stock judging, cattle rearing and milk sterilization. The five post-graduate students who had been at Bangalore from the beginning of 1924 spent a few weeks at the farm studying principally the special method of milk sterilization in use there.

Considerable trouble was experienced during the year in producing sterilized milk which would keep for an indefinite period; with a view to assist the management in this connection the Assistant Agricultural Bacteriologist from Pusa spent a week at the farm and gave valuable advice and assistance.

The Superintendent of the farm has now, however, overcome all the difficulties connected with this problem and is having no further trouble. Until these difficulties were completely overcome it was impossible to push the sale of our sterilized milk in Calcutta and Bombay, but this is now being done with encouraging results.

All the cattle which were of suitable age and in suitable condition were inoculated by an officer of the Imperial Veterinary Research Institute against rinderpest by the serum simultaneous method during the year.

During the year a boiler shed to accommodate the two steam boilers on the farm was erected, and the refrigerating and cold storage plant on the farm was over-hauled and put into thorough working order, and generally all the buildings and machinery on the farm have been kept in thorough repair.

Mr. F. J. Gossip was in charge of the farm throughout the year and in addition to his executive duties did valuable and arduous work in teaching the students who attended the farm from time to time.

The following appendices (I—VI) pertaining to the work of Karnal farm are attached :—

(1) Receipt and expenditure statements.
(2) Statement of outturn of grain and fodder, etc.
(3) Produce statement.
(4) Disposal of produce.
(5) Herd statistics.
(6) Statement showing yield of all cows which completed their lactation period during the period under report.

Bangalore. From the commercial point of view this farm suffered heavily during the year. Two severe outbreaks of foot-and-mouth disease broke out amongst the stock, and it was discovered towards the end of the year that Johne's disease was taking heavy toll of the herd. The cattle were carefully nursed through the two attacks of foot-and-mouth disease without casualties by the farm Superintendent and his staff, but the loss in milk yield alone owing to these two attacks cannot be estimated at less than Rs. 10,000.

The Director of the Imperial Institute of Veterinary Research at Muktesar very kindly deputed a special officer to investigate the question of Johne's disease. This officer was in attendance at the Bangalore and Wellington farms for four months of the year, and although his final tests have not yet been completed it is evident that this deadly disease is prevalent in the herd. The advice of the Director of the Imperial Institute of Veterinary Research will be carefully followed as to the best means of eradicating it. During the year seven animals actually died of suspected or ascertained Johne's disease, the book value of which was Rs. 2,195. Then again the dairy was badly hit commercially by a considerable reduction in the military demand for new milk.

The fullest possible use has been made of the farm as a training centre throughout the year. In February 1925, Government sanctioned the construction of an additional hostel with dining room, cook houses and bath rooms at a cost of Rs. 10,000. These buildings have just been completed and are now occupied by the diploma students.

The Institute co-operated during the year with the Physiological Chemist to Government by lending calves and full grown cows for digestion, feeding, and milk production experiments.

The cross-breeding policy of the military dairy farms regarding the greater part of the herd was continued during the year, but the pure bred Scindi herd and the small herd of Murra buffaloes are being developed on pure lines.

As the returns of the farm in the appendices show, both herds have done well and all suitable animals were inoculated by the serum simultaneous method for protection against rinderpest by an officer of the Imperial Institute of Veterinary Research, Muktesar. The farm continues to suffer financially from shortage of fodder producing land, but in this connection the Madras Government have very kindly consented to graze certain of the farm young stock at their cattle farm at Hosur. Unfortunately, it has been impossible to take advantage of this offer during the year owing to the fact that it was not known definitely which animals were free of Johne's disease and which were infected. As soon as the tests now being

carried out by the Imperial Institute of Veterinary Research are completed, it is hoped to send some of the older of the young stock for grazing to the Hosur Cattle Farm of the Madras Agricultural Department for part of the year, and the thanks of this department are due to the Director of Agriculture, Madras, and to the Deputy Director of Agriculture (Live-stock), for their readiness to assist us in this direction. All demands from military units, hospitals and institutions, were met during the year, and the military sanitary officers visited the dairy regularly and their recommendations have been at all times carried out.

During the year, the farm purchased 24 Scindi cows and 3 Ayrshire bulls, and during the same period 23 cows, 1 buffalo, 13 male young stock, 48 cow heifers and 3 bullocks were sold. rom the return herewith (Appendix XIII) it will be seen that fair prices were received for all fit animals sold, the actual figures realized being considerably greater than the book value of the animals at time of sale. The buildings and plant at the farm were kept in thorough repair throughout the year. An insulated cheese ripening room with air lock complete with brine drums and connections was sanctioned by Government and completed during the year. Steel cow shed fittings, in order to bring one of the existing cow sheds into line with modern practice and to illustrate to those being instructed at the dairy how a modern byre should be equipped, were purchased, and worn out and obsolete plant and utensils have been replaced where necessary. The policy of the institution as regards efficiency is to keep abreast of the times in so far as financial considerations permit.

Mr. F. E. Traynor was in charge of the Institute throughout the year, and, in addition to his executive duties as farm manager, he did much valuable work in instructing students. Mr. S. Cox was Assistant Superintendent for part of the year and also took part in the teaching work under Mr. Traynor's direction. The following appendices (VII—XIII) pertaining to Bangalore farm are attached :

(1) Receipts and expenditure statement.

(2) Statement of outturn of grain and fodder, etc.

(3) Produce statement.
(4) Disposal of produce.
(5) Herd statistics.
(6) Statement showing yield of all cows and buffaloes which completed their lactation period during the period under report.
(7) Statement of animals sold during the year.

Wellington. This farm has also been badly affected financially during the year by the prevalence of Johne's disease and contagious abortion in the herd. All the cattle have been tested for Johne's disease by an officer of the Imperial Institute of Veterinary Research and all reactors strictly segregated in accordance with the recommendations of the Director of the Imperial Institute of Veterinary Research under whose direction the herd is being treated by the vaccination method for the elimination of contagious abortion. It will, it is hoped, be possible to stamp out these diseases in the course of a few years. The Superintendent of the dairy estimates that the actual loss to the dairy during the year owing to deaths and loss in milk yields from these two diseases is not less than Rs. 5,926. All suitable animals were in the course of the year under review inoculated by the serum simultaneous method for protection against rinderpest. This work was done by an officer of the Imperial Institute of Veterinary Research, Muktesar.

During the year, the farm has met all demands from the various military units and institutions in Wellington and the dairy has been regularly visited by the military sanitary officers. Mr. S. Cox was in charge of the farm from 1st April to 16th October when Mr. A. Lamb took over charge on return from leave. Mr. Lamb remained in charge from that date until the end of the year.

The following appendices (XIV—XX) pertaining to the work of the Wellington farm are attached :—

(1) Receipts and expenditure statement.
(2) Statement of outturn of grain and fodder.
(3) Produce statement.
(4) Disposal of produce.
(5) Herd statistics.

(6) Statement showing yield of all cows which completed their lactation period during the period under report.

(7) Statement of animals sold during the year.

Although this report in regard to its general application deals with the year ending 30th June, 1925, it should be pointed out that the figures given in the appendices of all farms and referred to in the body of the report dealing with individual farms cover the period of the financial year ending 31st March, 1925. In these appendices will be found complete details concerning the working of each farm.

At the time of writing, the accounts of none of the farms have been audited by the audit department, and as it is likely that the audit will not be completed for some considerable time the audited trading accounts cannot be submitted with this report. These, however, will be submitted to Government as soon as they are certified by the Audit Department.

This department is under a very special obligation to the Director of the Imperial Institute of Veterinary Research, Muktesar, for the great help he has given and continues to give in connection with the detection, prevention and elimination of disease from all the three farm herds. Mr. Edwards' able advice and continued practical assistance is greatly appreciated and has been of the greatest benefit to the farms.

APPENDIX I.

Statement showing receipts and expenditure of the Imperial Cattle Breeding Farm, Karnal (Punjab), for the year 1924-25.

APPEN

Statement showing receipts and expenditure of the Imperial

Heads of receipts	Total Receipts	
	Cash	Book Debit
	Rs. A. P.	Rs. A. P.
Dairy produce.		
On credit	5,033 0 0	93 0 0
„ cash	2,883 0 0	..
„ coupons	..	..
Total	7,916 0 0	93 0 0
Capital receipts.		
Lands	..	..
Buildings	..	..
Live-stock, dairy	..	..
Live-stock, draught	190 0 0	..
Plant and machinery	580 0 0	1,100 0 0
Total	770 0 0	1,100 0 0
Miscellaneous receipts.		
Sales of skins	51 0 0	..
Grain and fodder	44,808 0 0	4,760 0 0
Other miscellaneous receipts	10,991 0 0	1,429 0 0
Total	55,850 0 0	6,189 0 0
Grand Total	64,536 0 0	7,382 0 0
Combined Total		71,918 0 0

DIX I.

Cattle Breeding Farm, Karnal (Punjab), for the year 1924-25.

Heads of expenditure	Total Expenditure	
	Cash	Book Debit
	Rs. A. P.	Rs. A. P.
Supplies and Services.		
Lands, improvements to lands and buildings	6,373 0 0	309 0 0
Plant, machinery and implements	4,426 0 0	14,199 0 0
Purchase of dairy cattle	15,782 0 0	3,282 0 0
Purchase of dairy cattle including replacement of casualties.	..	..
Total	26,581 0 0	17,790 0 0
Revenue items.		
Feed of dairy cattle	10,849 0 0	24 0 0
Chemical and other manufacturing sundries	11,611 0 0	321 0 0
Production of grain and fodder	4,380 0 0	8,730 0 0
Fuel, light, water and miscellaneous stores	2,484 0 0	205 0 0
Workshop	825 0 0	271 0 0
Medical stores	13 0 0	183 0 0
Freight on stores	1,452 0 0	1 0 0
Rent and repairs of buildings	1,904 0 0	..
Purchase of dairy produce	150 0 0	..
Total	33,668 0 0	9,735 0 0
Contingencies.		
Miscellaneous and refund of coupons	1,550 0 0	364 0 0
Establishment.		
Pay of officers	7,112 0 0	218 0 0
,, other establishment	13,416 0 0	..
Leave salary	..	..
Total	20,528 0 0	218 0 0
Allowances—T. A. and motor cycle.		
T. A. of (*a*) Gazetted officers	2,052 0 0	..
(*b*) Non-gazetted officers, etc.	62 0 0	..
Total	2,114 0 0	..
Grand Total	84,441 0 0	28,107 0 0
Combined Total		1,12,548 0 0

APPENDIX II.

Outturn of grain and fodder from the Imperial Cattle Breeding Farm, Karnal, during the year 1924-25, as compared with the previous year (9 months).

Particulars	1923-24 (9 months)	1924-25	Difference	
			Plus	Minus
	Md. Sr. Ch.	Md. Sr. Ch.	Md. Sr. Ch.	Md. Sr. Ch.
Gram seed	2,731 34 0	1,085 22 0	....	1,646 12 0
Barley	....	122 24 0	122 24 0	....
Wheat	1,771 0 0	893 5 0	....	877 35 0
Gram and wheat (mixed)	....	723 10 0	723 10 0	....
Oats seed	230 0 0	....	....	230 0 0
Ziri seed	2,011 35 4	3,071 26 0	1,059 30 12	....
Maize seed	....	43 27 0	43 27 0	....
Toria seed	2 38 12	....	....	2 38 12
Maize cobs	25 7 0	....	....	25 7 0
Gur	248 25 10	287 38 0	39 12 6	....
Mustard seed	....	21 24 4	21 24 4	....
	lb.	lb.	lb.	lb.
Anjan grass seed	120	....	....	120
Feeding hay	193,948	69,320	....	124,628
Bedding hay	5,029	....	....	5,029
Chari, dry	....	9,040	9,040	....
Oat straw	32,000	....	....	32,000
Wheat *bhoosa*	197,100	177,461	....	19,639
Mixed *bhoosa*	149,200	95,132 (dry)	....	54,068
Grass (green)	....	5,088 (or 3,392 dry)	5,088	....

NOTE. During the year 1923-24, the *rabi* crop was harvested in March 1924, whereas for 1924-25, the sum of Rs. 19,300 was credited in our account for standing crop (*vide* Audit Officer's remarks).

Total rainfall for the period 1st April 1924 to 31st March 1925 was 34·93 inches.

APPENDIX III.

Produce Statement of Imperial Cattle Breeding Farm, Karnal, for the year ending 31st March, 1925.

Number of Government owned animals in milk each day multiplied by number of days in year	Average yield of Government owned animals in milk per day	Average percentage of herd in milk during year	Milk								Butter manufactured	Ghi manufactured	Sterilized milk manufactured
			Produced by Government owned herd	Purchased from all sources	Sold as new milk	Separated	Cream produced	Cream sold	Separated milk produced	lb. milk required to make 1 lb. butter			
Cows	Cows	Cows											
	lb.		lb.	lb.	lb.	lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb.	lb. oz.	lb.
In milk . 15,928	8·4	60·4	134,079	3,007	73,792½	23,214	1,942 6	83 6	21,271 10	21 5	1,017¼	203 14	36,632½
				From separated milk								Found surplus lb.	From Experimental stock
				lb.									lb.
Dry . . 10,434	..	..	..	8,408½	..	..	..	..	..	..	..	1	29

APPENDIX IV.

Disposal of produce of Imperial Cattle Breeding Farm, Karnal, for the year ending 31st March, 1925.

NEW MILK						CREAM		BUTTER		GHI			RECEIPTS
SOLD TO								SOLD TO					
Hospitals and prisons	Officers and civilians	Farm employees	Loss	Separated milk fed to farm stock	Loss	Sold	Average price per lb.	Civilians and officers	Farm employees	Sold	Average price per lb.	Sterilized milk	Total for dairy produce as shown in the Cash Book
@ Re. 0-1-0 per lb.			lb.	lb.	lb.	lb. oz.	Rs. A. P.			lb. oz.	Rs. A. P.	lb.	Rs. A. P.
lb.	lb.	lb.						@ Rs. 1-4 per lb.	@ Rs. 1-4 per lb.			1,535 @ Rs. 0-1-0 per lb.	
	858½ @ As. 1½	5,987½ @ As. 1						lb.	lb. oz.			21 @ Rs. 0-1-6 per lb.	
	33,207½ @ As. 1	11,283½ @ As. 1¼						629¼	41 10			523½ as samples.	
	15,044 @ As. 1¼							As Cooking Butter				2,909 @ Rs. 0-4-6 *minus* 20 per cent.	
	253 @ As. 1-1½							Rs. A. P.	Rs. A. P.			22,584 @Rs. 0-4-0 *minus* 30 per cent.	
	6,766½ @ 18½ lb. per rupee							@0 15 0	@0 15 0			36 @Rs. 10-8-0 per dozen lb. with bottles.	
								lb.	lb. oz.			1,234 to farm stock	
392	..	..	745	12,058¼	804 14	83 6	1 0 0	12½	33 6	161 10	0 15 0	.. ..	8.007 1 2
	Separated 23,214 lb. Sterilized 36,632½ lb. To farm stock 10,970½ lb. To Experiment 140 lb.			To new milk 8,408½ lb.		Converted into butter 1,834 lb.		Converted into Ghi 264½ lb. Issued to farm stock 3½ lb. Issued as sample 10 oz.		11 8	0 14 0	6,212 found bad on turning cans.	
										8 8	0 12 0	86 thrown away.	
										Issued to farm stock 4½ lb.		35,140½ Total Disposal.	

Stock in hand at beginning and close of year.

	Sterilized milk	New milk	Separated milk	Cream	Butter	Ghi
	lb.	lb.	lb.	lb.	lb. oz.	lb. oz.
At 1st April 1924	..	..	..	..	.. ..	.. ..
At 31st March 1925	1,521	..	..	25	32 2	18 12

APPENDIX V.

Herd Statistics of Imperial Cattle Breeding Farm, Karnal, for the year ending 31st March, 1925.

	ADULT STOCK			YOUNG STOCK			CALVES				DRAUGHT CATTLE			
	Cows			Cows			Cows							
	Bulls	*Cows*		*Bulls*	*Heifers*		*Bulls*		*Heifers*		Cow bullocks	Cross bred	Buff bullocks	Ponies
	Country	Jersey	Country	Country	Jersey	Country	Jersey	Country	Jersey	Country				
Strength of herd on 1st April 1924.	2	..	61	1	3	1	..	27	1	26	16	4	..	2
Born	..	..	..	..	..	..	1	34	..	29	..	..	..	..
Purchased	2	..	38	..	..	..	..	15 with dams	..	19 with dams	..	..	..	..
Average price paid for animals purchased including freight at Rs.	435-10-3	..	392-0-7	..	..	..	..	..	..	..	..	..	1	..
Found spare on the farm	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Transferred from—														
Other Government dairies.	2	..	8	..	..	8	..	3	..	2	..	..	..	..
Young Stock	1	1	3	..	..	..	..	..	..	..	..	..	..	..
Calves	..	..	..	27	..	26	..	..	..	..	..	..	..	..
TOTAL	7	1	110	28	3	35	1	79	1	76	16	4	1	2
Transferred to—														
Other Government dairies.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Adult stock	..	..	..	1	1	3	..	..	..	..	..	..	..	..
Young stock	..	..	..	..	..	..	..	27	..	26	..	..	..	..
Lost	..	..	..	..	..	..	..	..	..	..	..	1	..	..
Died	1	..	6	..	2	..	1	9	1	8	..	..	..	..
Sold	..	..	..	..	..	..	..	..	..	..	2	..	..	..
Average price for animals sold.	..	..	..	..	..	..	..	..	..	..	Rs.40 each.	..	..	..
TOTAL	1	..	6	1	3	3	1	36	1	34	2	1	..	..
Strength of herd on 31st March 1925.	6	1	104	27	..	32	..	43	..	42	14	3	1	2

APPENDIX VI.

Yield of cows which have completed a lactation period during 1924-25 at Karnal.

No. of animal	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation	Remarks
			lb.		
1	Thar-Parkar	Unknown	1,360	96	
2	Do.	Do.	1,328	160	
3	Do.	Do.	952	188	
4	Do.	Do.	764	159	
5	Do.	Do.	441	127	
6	Do.	Do.	538	116	
7	Do.	Do.	1,796	191	
8	Do.	Do.	1,023	138	
9	Do.	Do.	1,836	191	
10	Do.	Do.	2,775	221	
11	Do.	Do.	1,560	236	
12	Do.	Do.	1,406	183	
13	Do.	Do.	972	157	
14	Do.	Do.	387	104	
15	Do.	Do.	1,426	158	
16	Do.	Do.	1,451	160	
17	Do.	Do.	1,066	174	
18	Do.	Do.	1,419	185	
19	Do.	Do.	1,195	159	
20	Do.	Do.	860	181	
21	Do.	Do.	3,273	228	
22	Do.	Do.	870	133	
23	Do.	Do.	43	120	Calf died in train.
24	Do.	Do.	1,314	188	
25	Do.	Do.	2,192	244	
26	Do.	Do.	737	130	
27	Do.	Do.	542	157	
28	Do.	Do.	1,372	164	
29	Do.	Do.	684	127	
30	Do.	Do.	1,082	198	
31	Do.	Do.	3,632	188	
32	Do.	Do.	3,333	188	
33	Do.	Do.	244	241	
35	Do.	Do.	998	30	
36	Do.	Do.	3,002	154	
37	Do.	Do.	1,562	298	
38	Do.	Do.	1,260	172	
39	Do.	Do.	550	137	Calf died 2 days after calving.
40	Do.	Do.	1,426	61½	
41	Do.	Do.	1,552	192	
42	Do.	Do.	1,974	170	
43	Do.	Do.	1,649	202	
44	Do.	Do.	3,574	211	
45	Do.	Do.	2,554	318	
46	Do.	Do.	482	299	
47	Do.	Do.	1,074	67	
48	Do.	Do.	1,357	164	
49	Do.	Do.	1,417	191	
50	Do.	Do.	1,204	192	

APPENDIX VI —*concld.*

Yield of cows which have completed a lactation period during 1924-25 at Karnal—concld.

No. of animal	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation	Remarks
			lb.		
51	Thar-Parkar	Unknown	1,089	249	
52	Do.	Do.	950	177	
53	Do.	Do.	2,486	167	
54	Do.	Do.	32	282	
55	Do.	Do.	1,806	43	
56	Do.	Do.	1,058	302	
57	Do.	Do.	802	170	
58	Do.	Do.	721	146	
				144	
59	Do.	Do.	207	60	
60	Do.	Do.	2,074	172	
63	Do.	Do.	1,709½	146	
64	Do.	Do.	58	75	
65	Do.	Do.	2,259½	263	
66	Do.	Do.	1,043	186	
67	Do.	Do.	1,042	107	
68	Do.	Do.	1,780	216	
69	Do.	Do.	1,084	113	

Note. (1) No cattle were sold during the period under review.
(2) The yields given in this statement represent part lactation as the animals were purchased in milk.

APPEN

Statement showing receipts and expenditure under different budget heads of for

Heads of receipts	Total Receipts	
	Cash	Book Debit
	Rs. A. P.	Rs. A. P.
Dairy produce.		
On credit	93,895 2 11	7,236 10 3
„ cash	5,316 5 0	..
„ coupons	32,182 12 0	..
Total	1,31,394 3 11	7,236 10 3
Capital receipts.		
Lands and Buildings	..	11,801 4 11
Live-stock, dairy	3,452 0 2	7,705 4 6
Live-stock, draught	44 2 0	..
Plant and machinery	..	960 0 0
Total	3,496 2 2	20,466 9 5
Miscellaneous receipts.		
Sale of skins	..	..
Grain and fodder	75 2 1	288 5 11
Other miscellaneous receipts	2,745 1 5	7,618 13 5
Fees from students	2,665 0 0	15 0 0
Total	5,485 3 6	7,922 3 4
Grand Total	1,40,375 9 7	35,625 7 0
Combined Total	1,76,001 0 7	..

DIX VII.

the Imperial Institute of Animal Husbandry and Dairying, Bangalore, 1924-25.

Heads of expenditure	Total Expenditure	
	Cash	Book Debit
	Rs. A. P.	Rs. A. P.
Supplies and Services.		
Lands, buildings and accessories	11,749 2 11	..
Plant and machinery	582 12 6	..
Purchase of dairy cattle	19,958 7 3	2,450 0 0
Purchase of draught cattle	..	..
Total of capital items	32,290 6 8	2,450 0 0
Rent and repairs to buildings	1,323 14 7	..
Repairs to plant and machinery	1,926 5 9	217 5 0
Feed of dairy cattle	42,655 12 0	8,074 7 1
Hire of cattle and purchase of dairy produce	44,939 12 6	859 3 0
Ice, salt and acid	1,077 4 0	..
Cultivation charges	109 5 0	..
Fuel, water and miscellaneous stores	9,539 6 3	19 12 9
Freight on stores	1,171 9 0	159 12 0
Total of revenue items	1,02,743 5 1	9,330 7 10
Contingencies.		
Miscellaneous charges and refund of deposits	6,990 9 7	437 2 0
Establishment.		
Pay of officers	8,924 8 0	..
Pay of other establishment	25,381 15 0	..
Total of establishment	34,306 7 0	..
Allowances,—T. A. and motor cycle.		
T. A. of (*a*) Gazetted officers	870 0 0	..
(*b*) Non-gazetted officers	497 0 6	..
Total of T. A. and other allowances	1,367 0 6	..
Grand Total	1,77,697 12 10	12,217 9 10
Combined Total	1,89,915 6 8	..

APPENDIX VIII.

Details of outturn of fodder from Farm lands at Bangalore and Bommanpalli, 1924-25.

Where grown	Description of fodder	Outturn in lb.
Bangalore	Green *jowar*	895,400
	„ grass	5,100
	„ Rhodes grass	1,200
	„ Guinea grass	265,260
	„ lucerne	234,385
	Dry *jowar*	28,690
	TOTAL Green	1,401,345
	TOTAL Dry	28,690
Bommanpalli	Hay	72,000

APPENDIX IX.

Produce Statement of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the year ending 31st March 1925.

NUMBER OF GOVERNMENT OWNED ANIMALS IN MILK EACH DAY MULTIPLIED BY NUMBER OF DAYS IN YEAR		AVERAGE YIELD OF GOVERNMENT OWNED ANIMALS IN MILK PER DAY		AVERAGE PERCENTAGE OF HERD IN MILK DURING YEAR		MILK								BUTTER				
Cows	Buffaloes	Cows	Buffaloes	Cows	Buffaloes	Produced by Government owned herd	Purchased from all sources	Sold as new milk	Separated	Cream produced	Cream sold	Separated milk produced	lb. milk required to make 1 lb. butter	Manufactured	*Purchased. See note I*		Average price paid per lb. for butter purchased	Cheese manufactured
															From Government farms	From other sources		
		lb.	lb.			lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	Rs; a. p.	lb.
In milk	In milk	In milk	In milk												From Wellington Institute			
36,978	1,211	14·9	16·9	72·82	62·84	5,69,938	21,062	3,85,043	69,947	6,992	1,345	62,955	19·97	2,805	560	35,962	1 3 2	
Dry	Dry	All over herd	All over herd						Cheddar cheese making						Surplus			Cheddar cheese
13,803	716	10·8	10·5						73,551						716			5,967
									Soft cheese making									Soft cheese
									480									82

APPENDIX X.

Disposal of produce of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the year ending 31st March, 1925.

NEW MILK						CREAM			BUTTER				CHEDDAR CHEESE			RECEIPTS	SOFT CHEESE		
To Wellington Institute	Sold			Loss	Separated milk fed to farm stock	Sold	Average price per lb.	Loss	Sold			Loss	Sold	Average price per lb.	Loss	Total for dairy produce as shown in the Cash Book	Sold	Average price per lb.	Loss
	To hospitals and prisons	To officers and civilians	To troops						To hospitals and prisons	To civilians and officers	To troops								
			To troops	Loss	Purchased	lb.	Rs. a. p.	lb.			To troops	Loss		Rs. a. p.	Issued as sample	Rs. a. p.	lb.	Rs. a. p.	lb.
22,030 lb. @ Rs. 0-3-3 per lb.	25,459 lb. @ Rs. 0-4-9 per lb.	65,427 lb. @ Rs. 0-3-6 per lb.	1,02,858 lb. @ Rs. 0-3-0 per lb.	13,714 lb.	393 lb.	1,345	1 12 0	..	1,554 lb. @ Rs. 2-0-0 per lb.	6,910 lb. @ Rs. 1-10-0 per lb.	19,061 lb. @ Rs. 1-8-0 per lb.	6 lb.	665 lb. @ Rs. 1-8-0 per lb.	1 8 0	23 lb.	1,38,630 14 2	76	1 8 0	6
			To married families	To Farm stock	Home						To married families	To Farm stock							
	79,476 lb. @ Rs. 0-3-6 per lb.		34,435 lb. @ Rs. 0-2-0 per lb.	47,200 lb.	62,955 lb.				4,309 lb. @ Rs. 1-10-0 per lb.	794 lb. @ Rs. 1-2-6 per lb.	3,314 lb. @ Rs. 1-6-0 per lb.	36 lb.	18 lb. @ Rs. 1-8-6 per lb.						
			To married families 55,358 lb. @ Rs. 0-2-6 per lb.	For Experiment 500 lb.							To Wellington Institute 3,300 lb. @ Rs. 1-2-6 per lb.		11 lb.						

Stock in hand at beginning and close of year.

	New milk	Cream	Butter	Cheddar cheese
	lb.	lb. oz.	lb.	lb.
At 1st April 1924	80	0 2	149	....
At 31st March 1925	645	48 14	907	5,250

APPENDIX XI.

Herd Statistics of the Imperial Institute of Animal Husbandry and Dairying, Bangalore, for the year ending 31st March, 1925.

	ADULT STOCK				YOUNG STOCK				CALVES				DRAUGHT CATTLE			
	COWS		BUFFALOES		COWS		BUFFALOES		COWS		BUFFALOES					
	Bulls	Cows	Bulls	Cows	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Bulls	Heifers	Cow bullocks	Buffaloe bullocks	Mules	Ponies
Number in herd on 1st April 1924.	6	137	1	6	5	69	2	..	27	52	1	2	26	2	2	11
Born during year .	..	..	..	..	..	..	..	..	58	69	2	2	..	..	..	..
Purchased during year.	3	24	..	..	..	..	..	..	13	8	..	..	..	..	..	..
Received from Wellington Institute.	..	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Heifers transferred to milking herd.	..	26	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Transferred from "Calves".	..	..	..	..	21	71	1	2	..	..	..	..	..	..	..	..
TOTAL .	9	193	1	6	26	140	3	2	98	129	3	4	26	2	2	11
Transferred to cows	..	..	..	..	..	26	..	..	..	..	..	..	..	..	..	..
Transferred to other farms.	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Died . . .	2	7	..	..	..	17	..	..	61	20	..	..	1	1	..	1
Sold . . .	..	23	..	1	13	48	..	..	..	..	..	..	3	..	..	..
Calves transferred to "Young Stock".	..	..	..	..	..	..	..	..	21	71	1	2	..	..	..	..
TOTAL .	3	30	..	1	13	91	..	..	82	91	1	2	4	1	..	1
Number in herd on 31st March 1925.	6	163	1	5	13	49	3	2	16	38	2	2	22	1	2	10

APPENDIX XII.

Yield of all cows and buffaloes which completed a lactation period during 1924-25 at Bangalore.

No. of Cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation
			lb.	
441	¾ Ay. Hissar	11	7,220	334
513	¾ Ay. Sahiwal	10	6,390	279
319A	¾ Ay. Scindi	4	6,351	320
820	¾ Ay. Hansi	8	6,219	258
828	¾ Ay. Hissar	8	6,070	297
434	Do.	10	5,550	291
893	¾ Ay. Sahiwal	7	5,373	312
766	¾ Ay. Hansi	8	5,055	255
288A	¾ Ay. Scindi	5	5,053	..
204A	Do.	8	4,988	398
504	¾ Ay. Hissar	9	4,883	326
231A	¾ Ay. Sahiwal	6	4,333	272
207A	¾ Ay. Scindi	8	4,222	303
309A	Do.	4	3,943	365
315A	Do.	4	3,867	407
173A	¾ Ay. Hissar	5	3,82	260
192A	Do.	5	3,678	356
786	¾ Ay. Hansi	..	3,50	254
297A	Do.	5	2,316	379
234A	⅞ Ay. Scindi	5	3,175	367
226A	¾ Ay. Scindi	..	3,044	225
301A	Do.	5	2,784	285
241A	¾ Ay. Sahiwal	6	2,600	247
223A	¾ Ay. Scindi	6	2,576	195
429	¾ Ay. Hansi	10	2,533	196
310A	⅞ Ay. Hissar	5	2,392	251
327	H. B. Ay. Scindi	4	2,223	242
164A	Do.	6	1,660	217
495	H. B. Ay. Sahiwal	10	1,351	197
165A	H. B. Ay. Scindi	6	1,081	136
523	H. B. Ay. Sahiwal	9	9,99	332
133	H. B. Ay. Hissar	16	8,651	321
286A	H. B. Ay. Scindi	4	6,879	313
80A	Do.	8	6,743	371
961	H. B. Ay. Sahiwal	7	6,685	291
295A	H. B. Ay. Scindi	4	6,575	396
927	Do.	7	6,383	285
888	H. B. Ay. Hansi	7	6,170	318
500	H. B. Ay. Sahiwal	10	6,088	305
934	H. B. Ay. Thar-Parkar	7	5,996	332
834	H. B. Ay. Sahiwal	8	5,905	405
135A	H. B. Ay. Scindi	10	5,810	321
268A	Do.	4	5,759	288
858	H. B. Ay. Sahiwal	8	5,579	283
955	H. B. Ay. Scindi	7	5,525	229
254A	Do.	5	5,485	337
326A	Do.	4	5,452	336
821	Do.	8	5,449	305
316A	Do.	4	5,269	369
812	H. B. Ay. Sahiwal	8	5,266	246
78A	H. B. Ay. Scindi	8	5,224	269

APPENDIX XII—*contd.*

Yield of all cows and buffaloes which completed a lactation period during 1924-25 at Bangalore—contd.

No. of Cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation
			lb.	
263A	H. B. Ay. Scindi	5	5,217	362
903	Do.	7	5,178	292
189A	Do.	5	5,659	405
45?	H. B. Ay. Sahiwal	10	4,928	327
314A	H. B. Ay. Scindi	4	4,909	356
440	H. B. Ay. Sahiwal	10	4,737	262
292A	H. B. Ay. Scindi	4	4,664	196
280A	Do.	4	4,574	309
406	H. B. Ay. Hansi	11	4,501	255
829	H. B. Ay. Scindi	8	4,451	264
257A	Do.	5	4,320	303
967	H. B. Ay. Sahiwal	6	4,314	243
344	H. B. Ay. Scindi	12	4,?95	334
997	Do.	6	4,068	303
840	H. B. Ay. Hansi	8	3,970	271
918	H. B. Ay. Scindi	7	3,766	250
308	Do.	4	3,646	328
78A	Do.	8	3,618	? 69
77A	Do.	8	3,606	267
100A	Do.	8	3,580	266
904	Do.	7	3,474	?32
847	Do.	8	3,385	264
188A	Do.	5	3,306	248
328A	Do.	4	3,275	296
825	Do.	8	3,181	30?
?18A	Do.	5	3,107	315
972	H. B. Ay. Sahiwal	6	3,107	255
896	H. B. Ay. Scindi	7	3,078	358
962	Do.	7	2,829	231
236A	Do.	5	2,450	239
327	Do.	4	2,223	242
164A	Do.	6	1,660	217
495	H. B. Ay. Sahiwal	10	1,351	197
166A	H. B. Ay. Scindi	6	1,081	136

No. of Buffalo.	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation
			lb.	
5	Murrah	1?	6,405	389
2	Do.	10	5,049	278
4	Do.	10	5,010	289
1	Do.	10	3,988	252
3	Do.	10	3,198	314

APPENDIX XII—*concld.*

Yield of all cows and buffaloes which completed a lactation period during 1924-25 at Bangalore—concld.

No. of Cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation
			lb.	
11	Scindi	9	5,506	389
19	Do.	11	4,298	298
899	Do	13	3,851	304
5	Do.	9	3,733	286
2	Do.	9	3,537	291
12	Do.	9	3,270	326
14	Do.	10	3,237	250
8	Do.	10	2,993	226
7	Do.	9	2,809	298
9	Do.	9	2,337	228
18	Do.	10	2,293	184
6	Do.	11	2,110	215
10	Do.	8	2,081	182
3	Do.	11	1,973	206
1	Do.	10	1,930	173
15	Do.		1,814	165
7	Do.	10	1,811	175
16	Do.	9	1,694	164
13	Do.	10	416	347

APPENDIX XIII.

Animals sold from Bangalore during 1924-25 other than by auction sales.

No.	Breed	Book value	Value realized
	Cows and heifers.	Rs.	Rs.
445	H. B. Cow	370	370
284A	Do.	275	285
370	¾ B. Heifer	230	300
382A	H. B. Ay. Scindi	150	180
503	Do.	60	110
340A	¾ Ay. Hissar.	260	250
350A	15/16 Ay. Scindi	100	160
351A	15/16 Ay. Sahiwal	130	175
355	¾ Ay. Scindi	250	250
365	⅞ Holstein Cross	160	150
367	⅞ Ay. Holstein Scindi	160	180
369	⅞ English	200	200
376	¾ Holstein Ay. Sahiwal	160	210
383	¾ Holstein Ay. Hansi	120	160
384	⅞ Ay. Sahiwal	110	130
385	⅞ Ay. Hissar.	100	140
387	⅞ Holstein Ay. Sahiwal	110	130
390	¾ Ay. Hissar.	110	180
391	⅞ Ay. Sahiwal	120	150
395	¾ Holstein Ay. Scindi	120	150
403	⅞ Do.	100	140
404	¾ Ay. Scindi	100	130
405	⅞ Holstein Ay. Scindi	100	150
519C	¾ Ay. Scindi	30	75
525C	⅞ Holstein Ay. Hissar	..	100
526C	¾ Ay. Hansi	..	80
529C	♀ Ay. Thar-Parkar	..	70
381	H. B. & H. B.	100	130
393	Do.	110	135
401	H. B. & H. B. Ay. Sahiwal	110	140
402	Do.	90	120
407	H. B. & H. B. Ay. Scindi	100	125
408	Do.	90	140
507C	H. B. & H. B. Ay. Sahiwal	40	100
541	Scindi	..	100
542	Do.	..	100
544	Do.	..	100
545	Do.	..	100
	TOTAL	..	5,895
	Male calves.		
518	¾ Ay. Scindi	..	100
519	Do.	..	100
522	Do.	..	100
524	⅞ Holstein Ay. Hissar	..	100
530	¾ Ay. Sahiwal	..	52½
531	⅞ Holstein Ay. Hissar	..	52½
533	⅞ Holstein Ay. Hansi	..	52½
539	Scindi	..	52½
542	Do.	..	52½
546	Do.	..	52½
551	¾ Ay. Sahiwal	..	52½
552	¾ Ay. Scindi	..	52½
	GRAND TOTAL	..	6,715

APPEN

Statement showing receipts and expenditure under different budget heads of for

Heads of receipts	Total Receipts	
	Cash	Book Debit
	Rs. A. P.	Rs. A. P.
Dairy produce.		
On credit	52,489 4 0	840 0 0
,, cash	6,712 1 9	..
,, coupons	17,445 0 0	..
Total	76,646 5 9	840 0 0
Capital receipts.		
Lands	..	..
Buildings	..	..
Live-stock	2,178 0 0	2,450 0 0
Plant, machinery and implements	..	..
Total	2,178 0 0	2,450 0 0
Miscellaneous receipts.		
Sale of skins	..	..
Grain and fodder	2,068 14 10	52 3 3
Other miscellaneous receipts	1,173 8 6	712 8 9
House rent	286 10 3	..
Total	3,529 1 7	764 12 0
Grand Total	82,353 7 4	4,054 12 0
Combined Total	86,408 3 4	

DIX XIV.

the Imperial Institute of Animal Husbandry and Dairying, Wellington, 1924-25.

Heads of expenditure	Total Expenditure	
	Cash	Book Debit
	Rs. A. P.	Rs. A. P.
Supplies and Services.		
Lands, improvements to lands, buildings and accessories.	2,322 12 0	674 4 3
Plant, machinery and implements	..	526 0 0
Purchase of dairy cattle including replacement of casualties	2,287 8 0	3,108 0 0
Total of capital items	4,610 4 0	4,308 4 3
Rent and repairs to buildings including taxes	857 0 6	..
Repairs to plant and machinery	731 3 0	83 10 0
Feed of dairy cattle	10,815 14 10	9,648 15 6
Hire of cattle and purchase of dairy produce	20,849 8 0	6,697 5 6
Chemicals and other manufacturing sundries	197 12 0	0 12 0
Production of grain and fodder, cultivation charges	707 12 0	46 14 0
Fuel, light, water and miscellaneous stores	3,874 10 6	221 3 1
Workshops	..	..
Medical stores	12 10 0	472 1 0
Freight on stores	1,637 11 0	..
Total of revenue items	39,684 1 10	17,170 13 1
Miscellaneous charges (refunds of coupons and deposits excepted)	1,127 8 6	668 15 6
Establishment.		
Pay of officers	5,696 8 0	..
Pay of other establishment	13,731 2 0	..
Total of Establishment	19,427 10 0	..
Allowances—T. A. and motor cycle, etc.		
T. A. and motor cycle allowances, officers and establishment.	980 10 0	45 0 0
Grand Total	65,830 2 4	22,193 0 10
Combined Total	88,023 3 2	

APPENDIX XV.

Outturn of grain and fodder crops of the Imperial Institute of Animal Husbandry and Dairying, Wellington, during the year 1924-25.

TOTAL AREA OF THE LAND IN POSSESSION OF THE DAIRY				1924-25							REMARKS
Arable	Grazing	Forest land for fuel	Building site	Total area of land under cultivation	Total outturn in green	Total expenditure incurred on cultivation	Production rate per 100 lb.	Total fodder purchased in green	Total amount paid for purchased fodder	Average purchase rate per 100 lb.	
Acres	Acres	Acres	Acres	Acres	lb.	Rs. A. P.	Rs. A. P.	lb.	Rs. A. P.	Rs. A. P.	
								5,17,450	6,865 8 2	1 5 2	Purchased as dry fodder and reduced in terms of green.
15·10	40·61	7·0	6·08	14·75	3,61,420	1,017 4 7	0 4 6	1,48,185	2,025 1 1	1 5 10	Purchased as green fodder.

APPENDIX XVI.

Produce Statement of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for the year ending 31st March, 1925.

NUMBER OF GOVERNMENT OWNED ANIMALS IN MILK EACH DAY MULTIPLIED BY NUMBER OF DAYS IN YEAR		AVERAGE PERCENTAGE OF HERD IN MILK DURING YEAR	MILK								BUTTER			
												Purchased		Average price paid per lb. for butter purchased
Cow:		Cows	Produced by Government owned herd	Purchased from all sources	Sold as new milk	Separated	Cream produced	Cream sold	Separated milk produced	lb. milk required to make 1 lb. butter	Manufactured	From Govt. farms	From other sources	
			lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	Rs. a. p.
		Over herd in milk												
In milk .	15,274	15·29	72·86	2,33,597	29,483	2,05,408	35,140	3,007	1,205	32,132	23·04	910	3,300	16,138	1 3 4
		Over whole herd												
Dry .	5,690	11·14												
TOTAL .	20,964													

APPENDIX XVII.

Disposal of produce of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for the year ending 31st March, 1925.

NEW MILK				SEPARATED MILK			CREAM		BUTTER				RECEIPTS
SOLD TO			Loss						SOLD TO			Loss	
Hospitals and prisons	Officers and civilians	Troops		Sold	Average price per lb.	Fed to farm stock	Sold	Average price per lb.	Hospitals and prisons	Civilians and officers	Troops		Total for dairy produce as shown in the Cash Book
Rs. A. P.	Rs. A. P.	Rs. A. P.	lb.	lb.	Rs. A. P.	lb.	lb.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	lb.	Rs. A. P.
@ 0 5 6 per lb. 11,815 lb.	@ 0 3 9 per lb. 14,117 lb.	@ 0 3 3 per lb.							@2 0 0 per lb.	@1 10 0 per lb.	@1 8 0 per lb.	..	..
@ 0 4 0 per lb.	@ 0 4 0 per lb.	71,460 lb.	3,433	402	0 2 0	31,730	1,205	1 12 0	651 lb. @1 10 0 per lb.	5,248 lb.	10,632 lb.	.. 18 lb.	.. 77,486 5 9
27,310 lb.	26,515 lb.	Families @ 0 2 0 per lb. 24,552 lb. @ 0 2 6 per lb. 29,639	Separated 35,140 Farm stock 19,202				Churned 1,794		1,465 lb.		Families @1 6 0 per lb. 2,335 lb.	Farm stock 80 lb.	

Stock in hand at beginning and close of year.

	New milk	Cream	Butter
	lb.	lb.	lb.
At 1st April 1924	198	1	207
At 31st March 1925	95	9	126

APPENDIX XVIII.

Herd Statistics of the Imperial Institute of Animal Husbandry and Dairying, Wellington, for the year ending 31st March, 1925.

	ADULT STOCK		YOUNG STOCK		CALVES		DRAUGHT CATTLE	
	Cows		Cows		Cows			
	Bulls	Cows	Bulls	Heifers	Bulls	Heifers	Cow bullocks	Ponies
Strength of herd on 1st April 1924	2	64	1	20	4	16	14	3
Born	..	..	..	..	31	22	..	..
Purchased	1	..	..	..	..	..	..	..
Average price paid for animals purchased including freight.	Rs. 2,287-8-0	..	..	..	..	..	..	..
Transferred from—								
Young Stock	1	3	..	..	..	..	..	..
Calves	..	..	3	11	..	..	..	..
TOTAL	4	67	4	31	35	38	14	3
Transferred to—								
Other Government dairies	..	6	..	..	..	..	..	..
Adult stock	..	..	1	3	..	..	..	..
Young stock	..	..	..	..	3	11	..	..
Disposed of being too small and no offer	..	..	..	..	1	..	..	..
Died	..	3	..	..	9	9	..	..
Sold	..	4	..	9	21	8	..	..
Average price for animals sold	..	Rs. 59-8-0	..	Rs. 203-0-0	Rs. 2-9-0	Rs. 20-0-0	..	..
TOTAL	..	13	1	12	34	28	..	..
Strength of herd on 31st March 1925	4	54	3	19	1	10	14	3

APPENDIX XIX.

Yields of cows which completed a lactation period during 1924-25 at Wellington.

No. of Cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation	Remarks
			lb.		
1	Ayrshire . .	3½	4,259	268	Yield cut short by contagious abortion.
11	Do. . .	3½	3,612	232	
111	Do. . .	3	4,086	190	Cut short by contagious abortion.
112	¾Jersey Ay. Scindi	8	4,737	231	
5	Ay. Hansi . .	14	3,723	259	
15	Do. . .	13	4,771	231	
830	Do. . .	7	5,283	250	
957	Do. . .	6½	3,482	239	
110	Do. . .	10	3,534	197	
117	Do. . .	7	5,665	290	
497	Do. . .	9	6,502	405	
709	Do. . .	8	9,270	356	
851	Do. . .	7	2,736	142	Yield cut short by contagious abortion.
851	Do. . .	7½	1,575	165	Yield of abortion period.
857	Do. . .	7	5,982	298	
924	¾ Ay. Hansi . .	6	4,749	280	
948	Do. . .	6	3,540	264	
4	Ay. Scindi . .	14	3,851	146	Small yield due to abortion. Previous yield 9,471 lb.
7	Do. . .	14	4,071	274	
8	Do. . .	14	3,161	225	Small yield due to contagious abortion. Previous yield 7,228 lb.
14	Do. . .	13	4,616	278	
18	Do. . .	13	3,176	232	
23	Do. . .	12	4,252	237	
24	Do. . .	12	640	112	This yield was result of contagious abortion. Average yield over 4,000 lb.
27	Do. . .	12	7,694	280	Would have been higher but cut short by premature birth.
27	Do. . .	13	1,447	190	Premature birth referred to above.
32	Do. . .	11	6,757	343	
42	Do. . .	10	3,408	227	
118	Do. . .	7	1,076	150	Trouble at calving. Cause of less yield. Average lactation 4,200 lb.
121	Do. . .	6	3,412	214	Yield cut short by contagious abortion. Previous yield 6,000 lb.

APPENDIX XIX—*concld.*

Yields of cows which completed a lactation period during 1924-25 at Wellington—concld.

No. of Cow	Breed	Age	Quantity of milk given during lactation	No. of days required for lactation	Remarks
			lb.		
121	Ay. Scindi . .	6	467	94	Yield of abortion period referred to above.
123	Do. . .	6	1,188	172	Trouble at calving. Previous yield 5,446 lb.
159A	Do. . .	6	4,660	221	Yield cut short by contagious abortion.
228A	Do. . .	4	2,744	254	
258A	Do. . .	4	3,775	298	
590	Do. . .	8	2,125	199	Only two teats yielding.
706	Do. . .	8	5,560	295	
838	Do. . .	8	3,396	253	
868	Do. . .	6½	4,024	210	Yield cut short by contagious abortion.
868	Do. . .	7	2,028	216	Yield of abortion period.
11	Shorthorn Scindi .	13	7,283	405	
19	Do. .	12	5,180	370	
111	Do. .	10	5,936	265	
32A	Scindi . . .	5½	3,551	275	
425	Do. . . .	8	2,976	244	

APPENDIX XX.

Animals sold from Wellington during 1924-25 other than by auction sales.

No. of cow heifer	Breed	Book value	Value realized
		Rs.	Rs.
127	Half-bred	200	300
136	Do.	120	300
154	¾ Ay. Scindi	100	300
155	Half-bred	75	160
162	Do.	70	160
163	Do.	75	160
169	¾ Ay. Scindi	80	160
177	Do.	100	275
	TOTAL .	820	1,815

REPORT OF THE PHYSIOLOGICAL CHEMIST.

(F. J. Warth, M.Sc.)

I. Charge.

I was in charge of the Section throughout the year.

II. Extension and Improvement.

Analytical work in the new laboratory commenced in July 1924. It was very soon discovered that some extension would be necessary. Two new laboratory rooms were sanctioned and have been constructed. This additional space has greatly relieved the pressure and has also made it possible to improve the older rooms. The preparation room has been transferred, the nitrogen room has been enlarged and the drying ovens have been made into a permanent fixture, thereby economizing heat and utilizing it further for drying racks. Analytical work has not been interrupted in spite of the inconveniences caused by the alterations and extension. A new burner has been designed. This has proved itself a success and has greatly relieved the situation in the matter of heating, which is, however, still a source of some anxiety.

III. Laboratory Work.

Testing of analytical methods. Procedures for the storage of fæces and for silage and urine analysis have been studied. The storage of fæces and preparation of composite samples for analysis has absorbed a considerable amount of work. The subject is of the greatest importance in all digestion experiments. Ice being a luxury and very hard to obtain so far from the town, other methods have been employed for preserving samples

required in ordinary routine work. The aim has also been to devise methods of storage which will enable us to transport samples if necessary, thus making it possible to carry out experiments at a distance from the laboratory. The procedures devised have been proved so far to be entirely effective for determining the nitrogen content of the fæces. Further work is in progress. The analysis of silage with regard to its nitrogen content is an extremely difficult matter when great accuracy is required, as, for instance, in nitrogen balance experiments. A procedure which seems satisfactory has been evolved for this work. It has still to be more fully tested.

Analyses in connection with feeding experiments. The following analyses have been carried out during the past year :—

Complete analyses—fodders . . .	61	
Ditto fæces . . .	89	
		150
Dry matter in fæces	1,130	
Ditto milk	72	
Ditto urine	183	
		1,385
Single nitrogen determinations		821
Mineral analyses—foods and fæces . . .		67
Complete analyses—urine		106
Ditto butter		4
Ditto cream		3
TOTAL .		2,536

IV. Feeding Experiments.

The work carried out during the past year has been confined to a study of the foodstuffs used in the dairy. Calves, heifers and cows in milk were tested. A few of the observations made during the course of the experiments are worth remarking on.

The accompanying table shows (*a*) average daily gain in weight during 100 days; (*b*) average daily food consumption during a digestion experiment by two lots of six heifers.

		Average daily gain in weight	Daily rations in grm.		Total dry matter	Ratio of roughage to concentrate	Percentage digestibility of ration	Breed
			Roughage	Concentrate				
		lb.						
Average age 10 months	1	0·919	2,602	1,237	3,839	2·10	47·90	¾-Ayrshire-Scindi.
	2	1·112	3,145	1,237	4,382	2·54	51·57	⅝-Holstein-Ayrshire-Scindi.
	3	1·058	2,612	1,237	3,850	2·11	49·00	¾-Ayrshire-Hansi.
	4	0·933	2,436	1,237	3,673	1·97	49·29	¾-Ayrshire-Scindi.
	5	1·113	3,221	1,237	4,958	2·60	48·90	⅞-Holstein-Ayrshire-Scindi.
	6	0·923	2,556	1,237	3,793	2·07	52·24	¾-Ayrshire-Thar-Parkar.
Average age 16 months	7	1·239	3,958	1,650	5,608	2·40	53·44	⅞-Holstein-Ayrshire-Scindi.
	8	0·496	2,926	1,589	4,515	1·84	55·76	¾ Ayrshire-Scindi.
	9	1·264	4,403	1,650	6,053	2·67	51·94	⅞ Holstein-Ayrshire-Scindi.
	10	0·792	3,416	1,650	5,066	2·07	52·54	¾-Ayrshire-Scindi.
	11	0·950	3,365	1,650	5,015	2·04	55·70	Half-bred × Half-bred.
	12	0·934	3,428	1,650	5,078	2·08	48·08	Half-bred × Half-bred.

The concentrate was fed in definite amounts, while the animals were given hay (roughage) *ad lib.* The differences in roughage consumption and the ratio of roughage to concentrate are significant figures. These data show up those animals which have good appetites and a capacity for consuming roughage. In this respect two animals of the younger lot and two of the older lot stand out clearly above the others, and it is noteworthy that these four animals have Holstein blood in them. It will be noted also that these four animals made greater daily gains in weight than any of the others.

The table also affords interesting information conc rning the digestion of the ration. Generally speaking, roughage is less easily and less completely digested than concentrate. It might have been expected, therefore, that the animals which consumed a higher proportion of roughage would show a lower digestion of the entire ration. The digestion figures obtained

do not support this view. They emphasize differences in individual digestive capacity.

The work with these heifers has yielded useful information on the digestibility and production values of the rations employed. The data are being prepared for publication.

A set of figures referring to the utilization of protein by calves is shown below. Six calves were given the rations specified in the accompanying table. Towards the end of the feeding test a digestion experiment was carried out. The following results were obtained.

Calf No.	Ration	Increase of live weight in 50 days	Daily net energy available for growth	Protein in grm.		Daily nitrogen digested	Nitrogen voided in urine	Nitrogen assimilated	Nitrogen available for assimilation	Percentage utilization of nitrogen
				Consumed	Digested					
		lb.								
1	Cake, Guinea-grass and hay.	4·6	526 C	270	194	30·39	27·45	2·94	24·13	12·2
2		2·7	643 C	273	195	28·91	26·34	2·07	22·78	9·1
3	Bran, Guinea-grass and hay.	30·7	674 C	203	103	15·65	10·13	5·52	7·18	76·9
4		12·1	270 C	135	76	11·48	5·54	5·94	6·16	96·4
5	Cake, bran, Guinea-grass and hay.	21·0	866 C	233	155	24·07	18·41	6·66	18·14	35·4
6		26·3	762 C	233	150	23·53	17·65	5·88	17·60	33·4

It should be mentioned that these calves were a very poor lot when put under experiment. They were undersized and underfed. The four last recovered their vigour, the first two did not. The ration given to these two animals is not suitable for young calves certainly, but these calves were six months old. We have to consider in what respect the ration was inadequate. The data show that these calves are capable of digesting large amounts of protein. There is no lack of digestive capacity, but there is evidently some serious fault in the utilization of the digested material, for whereas the calves on a bran ration utilized 88 per cent. of the available nitrogen for flesh formation, the calves receiving cake utilized only 10 per cent.

It is noteworthy that the estimated net energy of the food available for growth bears no relation to the observed rate of growth, and for the present it is by no means certain that

Armsby's net energy values can be applied to the rations used for these calves. There may have been a shortage of energy. The experiment was repeated with two other successive lots of calves and similar results were obtained in each trial.

The calf experiments are being continued. Some interesting results have been obtained in an experiment designed to determine the food cost of milk production with cross-bred cows. The data procured show that per pound of milk our cows used the same amount of total nutrients as Haecker's cows in America. This satisfactory result in spite of somewhat indigestible roughage may be due to the higher protein content of our ration. Compared with Eckles' net energy standard, our cows required slightly more net energy per pound of milk.

Haecker's and Eckles' figures here referred to as well as our figures used for this comparison are based on computed digestible nutrients, *i.e.*, they have been calculated from the ordinary digestion coefficients. They do not take into account the fact that the actual digestion attained by a heavily fed cow falls below this theoretical level.

Digestion experiments were carried out to determine the loss of potential food on account of heavy feeding. It was found that our cows digested some ingredients more completely and other ingredients less completely than the American cows. Our losses were on the whole less than those sustained by Eckles. The difference may be due either to better digestive capacity or to the fact that our cows had not to deal with quite such a heavy ration.

The actual nutrients and net energy used by cows for milk production is, as Eckles has pointed out, decidedly lower than the computed figures referred to above. He has also observed that the actual net energy required per pound of milk is less than the energy content of the milk, and that therefore the conception of net energy in relation to milk production requires to be further investigated. Our results corroborate and amplify this important conclusion.

The data obtained from this experiment are being prepared for publication. In the meantime similar work on a pure Indian breed—the Scindi—has been initiated.

V. Training of Post-graduate Students.

The training of post-graduates has been continued on the lines laid down in last year's report. Emphasis is laid on this training course which is one of the most important functions of the Nutrition Section. Five students passed through the course last year and two are undergoing training this year.

VI. Collaboration with Provincial Departments in work on Animal Nutrition.

During the past year lines of enquiry were suggested and detailed schemes of work prepared for the Madras and Mysore Departments of Agriculture.

VII. Programme of work for 1925-26.

Major subjects.

1. Determination of digestion coefficients of important Indian coarse fodders and concentrates.

2. The study of nitrogen metabolism of Indian cattle and the determination of maintenance rations. Some results of value have bee obtained during the past year. These will be prepared for publication in due course. The experiments will be continued with some modifications.

3. Study of rations for milk production. An experiment with half-bred cows has been completed during the past year. The results of this work have been submitted for publication. A more detailed enquiry on the same lines has been commenced with a pure Indian breed.

4. Experiments on the nutrition of growing animals. An experiment with young dairy heifers has been completed during the past year. The results of this work will be ready for publication in a short time. At present experiments with calves are in progress.

Minor subjects.

1. A study of some of the chemical methods employed in the above enquiries.

2. Preliminary experiments for the initiation of work on other aspects of nutrition.

Training.

1. The training of post-graduate students, which is an important branch of the work of this Section, will be continued as usual.

2. For the Diploma students a course in general science, plant chemistry, nutrition, and dairy chemistry is provided by this Section. The course will be continued and further developed.

REPORT OF THE GOVERNMENT SUGARCANE EXPERT.

(Rao Saheb T. S. Venkatraman, B. A.)

I. Charge and Staff.

I was in charge of the office of Government Sugarcane Expert, Coimbatore, for the whole year, except when on leave on average pay for six weeks. The Assistant Sugarcane Expert was in charge of the bulk of the routine work both in office and on the farm. I have to record with deep regret the death in January 1925 of my senior plant collector, A. Chinnayya Udayar. He was a very useful hand at the seedling house.

II. Research and Investigations.

Arrowing of sugarcanes. The arrowing of canes during the year started well but the seed setting was prejudicially affected by adverse weather conditions, chiefly rains, at the time. The thick varieties suffered more than the Indian canes in this respect. Over 200 cross-pollinations, involving operations on about 1,500 arrows, were made during the year. These gave about 200,000 seedlings and a large number of them possess very satisfactory vigour of growth.

During the season eight varieties of the Mungo group—the dwarf group of indigenous canes of North India—flowered, and 150 seedlings were raised between Lewari as mother and Co. 12 (a thick Coimbatore seedling) as father. This group of canes does not generally possess healthy pollen, and it was, till recently, thought they might be sterile in the pistils as well. This is the second year that seedlings have been raised from this class of canes and they are quite distinct from the rest. Information is continuing to be collected on the type of seedlings which the different varieties, or their combinations, give rise to.

Technique of breeding. Attempts were made to simplify further the technique involved in the breeding operations.

Cylindrical earthenware rings, open at both ends, were substituted for the seed pans with slanting sides in use hitherto for sowing the fluff. Another extensive innovation during the year was the pricking out of the seedlings into raised beds in the ground instead of into pots. Both the above were found to be distinct improvements, apparently because of the increased facilities for root development. Attempts to secure an alternative method for germinating sugarcane pollen, except on the stigmas of *Datura fastuosa*, proved futile.

Control of male fertility in sugarcane arrows. Persistent attempts were made to try and influence the fertility of the anthers in an arrow by suitable manipulations. The idea originated from an observation recorded in 1912 about the comparative absence of healthy anthers and healthy pollen in Saretha arrows obtained from saline land; in good soil this variety is rich in pollen. After experimenting in various directions, it was found that cane arrows could be partially fed on special solutions, by separating vertically a tongue of cane a good distance below the arrow, and inserting the free half into the solutions. Micro-chemical tests showed that the solutions reached to the top portions of the arrow in less than 12 hours. The results are yet inconclusive, but certain solutions appear to have an effect on the colour as well as the degree of opening of the anther sacs. It is proposed to continue the experiments on a more extended scale during the coming year. The utility of any success in these experiments in sugarcane breeding is obvious.

Breeding for provinces which are unable to germinate their own sugarcane seeds. While all the cane countries of the world stand to benefit by raising seedlings within their own boundaries and testing them under their own conditions, it is not all that possess the climatic advantages for cane flowering or germination of cane seeds. As early as 1920 a batch of sugarcane seeds—derived from the hardiest parents—was sent to Saharanpur in the United Provinces. With the hearty co-operation of the officer in charge of the Botanic Gardens there, an attempt was made to germinate the seeds at Saharanpur and grow them to maturity in the gardens. The seeds

were germinated inside a hot house and, at the end of a year, it was found that the seedlings had not grown sufficiently for selection. The matter was accordingly dropped at the time.

In January 1924 a batch of seeds was sent to the Government station at Anakapalle in the Northern Circars of the Madras Presidency to see if the Saharanpur experiment could be carried out with greater success in a locality with more favourable climatic conditions for the germination of cane seeds. The experiment was a fair success and, during the year, about 1,000 seedlings raised and grown at Anakapalle were studied and fifteen selections made. These selections are now being watched for their behaviour under field conditions.

At the instance of the Agricultural Adviser to the Government of India, Dr. D. Clouston, C.I.E., M.A., D.Sc., the question of extending the experiment to Pusa in Bihar has been taken up. The temperature conditions at Pusa and in the bulk of North India during the winter—just the time when the seeds are ready for sowing at Coimbatore—are such that it will be impossible to germinate them except inside a hot house ; and certain cane seeds lose vitality in a very short period. An experiment has, therefore, been started this year by despatching to Pusa a batch of young sugarcane seedlings instead of seeds and growing them under Bihar conditions even in the first instance. Any objection to the method, on the score that the seedlings during germination are subjected to a set of conditions different from those obtaining in the locality, would apply equally to the germination of seeds in the locality itself inside a hot house.

It has been found that young seedlings could thus be transported all the way from Coimbatore to Pusa—a distance of over 1,500 miles—in a fairly satisfactory manner if (1) adequate provision is made against desiccation during the journey, and (2) adequate precautions are taken in the packing to let in air and light to the seedlings.

There is more than one country in the world similarly situated as the provinces in North India, but, so far as one could see, the above experiment does not appear to have been

tried elsewhere. It is possible that the experiment might open out a new line of work in cane breeding. In this connection, it might be of some interest to mention that, as early as 1922, a batch of hardy sugarcane seeds was sent from Coimbatore to the United States of America, to the Bureau of Plant Industry in that country, and appears to have germinated after the journey. This is perhaps the first instance where cane seeds have been known to germinate after travelling such a long distance.

Work in the nurseries—a short cut to selection. Adverse weather conditions at the time prevented the planting of the seedlings, raised during the previous year, from the second nursery to the final test plots. Because of this the seedlings were allowed to grow in the nursery itself and rough selections made, chiefly, on vigour. Previous experience has shown that the useful seedlings are generally those which stand out from the rest in vigour of growth. About 1,400 selections were made and their present vigour of growth appears to indicate that there is something in such rough selections. There is plenty of vigour in them and, if any of them show the other desirable characters as well, the station would have hit upon some very promising seedlings with comparatively less testing and manipulation.

It is proposed, in future years, to allow more space between plants in the second nursery to enable selections being made from this nursery itself mainly on vigour and, to some extent, on sucrose contents. The method of "dead-leaf analyses," evolved at the station as early as 1917, would enable a rough comparison of the seedlings to be made even when they are immature. It is true such a method of selection would be rather rough but there would appear to be some use in such rough and ready selections. A recent writer in " Facts About Sugar" has pointed out that about 80 per cent. of the cane area in Java is under seedlings produced by the planters, and their selection, it may be assumed, would have been largely by rough and ready methods. A full exploitation of such methods, simultaneously with more detailed and elaborate work, appears to be desirable.

Disease incidence—mosaic. Some acquaintance with the diseases to which a crop is liable—at least the broader aspects of it—has a claim on the attention of the breeder. Breeding for disease-resistance is getting to be recognized as one of the most effective ways of checking certain diseases. This is particularly so in the case of the sugarcane ; cane breeding in Java largely resulted from an attempt to fight out the "Serrah" in that island. Recently the same prescription has been advocated for fighting out the more abstruse diseases like the mosaic.

Though India is generally considered to be free from mosaic, yet indications are not wanting to justify the opinion that the disease might have been present in the country for sometime past, though without being recognized as such.

In my last winter tour I noticed in the variety Red Mauritius, both at Samalkota and Palur in the Madras Presidency, symptoms very similar to those of mosaic. This is the first time that I came across canes so suspicious, and both the Java and the Hawaiian authorities have since definitely confirmed my suspicions. Red Mauritius is one of the varieties which is going out in more than one place in the Madras Presidency, and my noticing almost a hundred per cent. infection in this variety lends some support to the view that, in the past, certain introduced varieties might have gone out through mosaic.

If, as is possible, the mosaic has been in South India for some time, it is probable that the effects of the disease under Indian conditions are not as disastrous as elsewhere. The canes at the breeding station have so far shown no disease. It is possible that the freedom of the station from mosaic is largely due to the fact that the bulk of the crop is grown from seed—and mosaic is not said to be transmitted through seed. If it is found that mosaic is fairly prevalent in India, it would add one more important character to the list on which the selections are now made.

It is perhaps worth mentioning in passing that my Botany Assistant, Mr. R. Thomas, has recently found mosaic-like blotching of leaves in two of the grasses—*Cynodon dactylon* and

Co. 205 grown without irrigation at the Government Farm, Gurdaspur (Punjab). It yields about 50 per cent. more *gur* (raw sugar) than the local canes.

Co. 205 grown in a ryot's field under swamp conditions. It yields in such conditions also about 50 per cent. more *gur* (raw sugar) than the local canes.

Andropogon pertuses. It is further interesting that the Government Entomologist at Coimbatore has recorded *Aphis-maidis*—the insect said to be responsible for the transmission of cane mosaic in other countries—on *Cynodon dactylon.* The affected grass plants have so far refused to grow even under favourable conditions and the matter is being investigated.

III. Performance of Coimbatore seedlings in North Indian farms.

That the Coimbatore seedlings are found useful in Northern India and are spreading rapidly in almost every province there, will be evident from a perusal of the annual reports from the various provinces. The results of the present year will be available only after this report is written, but I give below some of the outstanding features as I was able to gather from my last winter tour.

The white sugar belt in Bihar, with its large concentration of sugar factories, is the tract where the Coimbatore seedlings have been most appreciated and have spread the greatest. This has resulted largely from the propaganda work of the Secretary, Sugar Bureau, Pusa, and his large scale mill tests. The two seedlings most favoured at present are Co. 210 and Co. 213, the former coming recently into favour in less favourably situated lands.

The seedling Co. 213 is proving a great success in parts of the Western Circle in the United Provinces. In the North-West Frontier Province it has shown an enormous growth, and in Bengal it has proved superior to Tanna, till now the favourite of the department.

The seedling Co. 205—a cross between Vellai and *Saccharum spontaneum*—is proving usefu' under a very wide range of conditions in the Punjab. It is only in typical *chahi* (irrigated from wells) areas that this seedling is not favoured on account of its late maturity. Its particular usefulness in water-logged areas, both in the Punjab and in the Western Circle of the United Provinces, might be considered a discovery of some importance during the year. The seedling ap-

pears to be rather remarkable in the wide range of conditions—from *barani* or unirrigated lands to heavily water-logged areas on river borders—in which it is able to grow and prove a success. It is essentially a poor man's cane, puts up with indifferent conditions and shows all the better in bad years.

In the Government farm at Cuttack, two Coimbatore canes, M. 2 and Co. 213, were the only ones which survived the abnormal drought conditions during the season. They have been introduced near Cuttack into tracts where cane was never grown before. Indications are not wanting that the coarser and the hardier of the Coimbatore productions might have a distinct role of usefulness in tracts less favourably situated for cane growing.

It would seem safe to assume that Coimbatore productions, as they begin to spread in the provinces, would materially help the industry, not only by increasing the yields over existing areas, but also by bringing under cane areas which are unable to grow the existing class of canes. The seedlings have brought on an appreciable change in outlook in the white sugar belt of Bihar.

IV. Maintaining Health and Vigour of Varieties.

The station grows year after year a very large number of varieties— sometimes over 3,000 plots, inclusive of the seedling varieties. A certain amount of care is needed both in keeping the plots pure and in maintaining the vigour of the existing varieties. The experience of the other countries is not without definite indications that the growing of a large number of varieties close to one another, as has to be done at Coimbatore, carries with it risks in the matter of diseases. The theory has recently been advanced that sugarcane varieties, in themselves quite healthy, might yet carry disease to others. Any variety which shows anything like a falling off in vigour is, therefore, mercilessly rejected and fresh importations made. Some half a dozen years back, an experiment was made, at renovating the vigour of varieties, by selecting a small number of healthy buds from clumps of undoubted vigour and health and multiplying the stock from these. The method had an

appreciable effect on the succeeding crop and was therefore applied to the varieties during the year under report.

V. Miscellaneous.

During the months of April, May and June, the lands near the existing cane-breeding station and within a radius of ten miles were examined for the selection of a site with a view to include work on the breeding of the thick class of canes. The best sites from the crop point of view were found at a distance of about five miles but were subsequently given up in favour of one which, though not quite as good, is much nearer, being only a little over a mile from the present station.

There is a considerable amount of sugarcane literature appearing in the Dutch language and the station was not able to get into touch with it till abstracts of the same appeared in English. Sub-Assistant G. V. James volunteered to study the Dutch language and was deputed to Madras for a period of four months to learn the language under a missionary. This officer has acquired such knowledge as to enable him to furnish a rough gist of published material, and is persevering with a view to enlarge his acquaintance with that language and thus become more useful to the station.

The visitors during the year included His Excellency the Governor of Madras; the Hon'ble the Minister for Development, Government of Madras; the Agricultural Adviser to the Government of India on two occasions; the Hon'ble Member of the Viceroy's Executive Council for Education, Health and Lands; and Mr. C. J. Olivier, a sugarcane planter from the Argentine. The last named gentleman visited only Coimbatore in South India and was so pleased with the health and vigour of the thin seedlings at the station that he left behind a couple of hundred rupees for sending to Argentine a few of the more promising kinds. The seedlings were despatched during the year.

VI. Publications.

A paper entitled "Sugarcane-breeding in India—Hybridization to testing" detailing the technique as adopted in the

breeding at Coimbatore was published during the year in the "Agricultural Journal of India."

The work of the station is beginning to attract attention from elsewhere and a note on the technique as adopted at Coimbatore was forwarded to more than one enquirer from outside. An abstract of this note has been published in the "Hawaiian Planters' Record" for January 1925.

The Proceedings of the Imperial Botanical Conference in London, July 1924, has published in extenso a note on sugarcane-breeding in India by the writer of this report.

VII. Programme of work for 1925-26.

Major.

The breeding work will be continued with the object of improving on the seedlings already distributed in one or more characters or to meet new demands.

Further investigations will be undertaken to improve the technique of breeding and to try and control arrow fertilities by suitable manipulations of the environmental conditions.

Minor.

Study of root development in sugarcane varieties and of the factors influencing cane germination will be continued during the year as time becomes available.

VIII. Conclusion.

The year under report marks a new epoch in the work and activities of the station. Started in the year 1912, the station has just been placed on a permanent basis after a rather abnormal probationary period of over a dozen years. During this period, while working under all the disadvantages that a temporary station is liable to, it has been able to achieve results which have made an impression on more than one Provincial Department of Agriculture, on the ordinary cultivator and on the shrewd business minded sugarcane planters of Bihar.

Its productions have come to be known in every province in Northern India from Peshawar to Bengal and are spreading rapidly in every one of them to the advantage of all concerned. In North Bihar, the Coimbatore seedlings, by their superior yields, have knocked the bottom out of the belief, till recently held, that that province could not grow a decent class of canes. It has been said that the Coimbatore canes "have put an entirely different complexion on the problem of sugar manufacture in Bihar." The results achieved during the comparatively short period have amply justified the monies expended on the station, and it is to be hoped that the success achieved will encourage both the Government and the industry to put more money into such activities in the future.

Though the funds of the station have come from the Central Government even from its very inception in the year 1912, yet its indebtedness to the Madras Department of Agriculture in the matter of housing and other accommodation, in allowing their trained staff to be seconded at the station, and in the general sympathetic attitude of successive Directors of Agriculture, deserves to be recorded.

REPORT OF THE SECRETARY, SUGAR BUREAU.

(Wynne Sayer, B.A.)

I held charge of the office of the Secretary, Sugar Bureau, throughout the year. The subordinate staff also remained unchanged, the term of the two Fieldmen appointed in the previous year being further extended. The Bureau continues on a temporary footing, its term having been extended up to 31st March, 1926, with the result that no definite programme of work could be laid down extending for more than a year.

Besides discharging its main function which is to collect information relating to the sugar industry and to make it available to the public, the Bureau carried on the testing of Coimbatore seedling canes and did other important work on the agricultural, commercial and industrial sides of this industry briefly described below :—

I. Agricultural.

As mentioned by me in my previous report, the Indian Sugar Producers' Association placed at my disposal a sum of Rs. 15,000 to enable me to carry on sugarcane work on a farm of about 143 acres called the New Area at Pusa, which the Government of India placed at the disposal of the Association in the first instance for one year* with effect from 1st April, 1924. The Budget grant made by the Government of India amounting to Rs. 3,000 was utilized for the preliminary experimental work of growing small plots of various Coimbatore seedlings for purposes of testing and for the maintenance of the museum attached to this Bureau. Besides this, an advance of Rs. 5,000 was taken from Messrs. Begg, Sutherland & Co. to grow cane for a further mill trial. But as the plant cane was grown on a plot of land which formed part of the New Area, and as Messrs. Begg, Sutherland & Co.

* This was subsequently extended for another year.

are members of the Indian Sugar Producers' Association, it was settled later on, with the concurrence of the parties concerned and with the approval of the Agricultural Adviser to the Government of India, to amalgamate this grant of Rs. 5,000 with the general grant of the Indian Sugar Producers' Association.

As a result of the distribution on a large scale, to growers in the white sugar tract, of the three improved varieties Co. 210, 213 and 214, some 1,500 acres were under these canes in the growers' fields during the season 1924, while over 5,000 acres have been planted this February. As mentioned by me in my previous report, the 1923 monsoon proved a complete failure with the result that the moisture in the land at the time of planting in February, 1924, was far from satisfactory. In consequence, the cane had to struggle hard to survive during the hot months, and in this struggle the local Hemja gave out completely, while the Coimbatore canes stood the conditions successfully. The monsoon of 1924 proved favourable, 54·18 inches of rainfall being registered against 24 inches in the previous year, and in the district where Coimbatore canes have been chiefly distributed the factory season was considerably extended.

The heavy rainfall of the season and the large number of cloudy and rainy days were favourable factors for disease. During the season some cases of chlorosis and a peculiar stunted growth and yellowing of the leaves and other symptoms diagnostic of mosaic were noticed. Some cases of a root disease apparently akin to collar rot, red rot and smut were also noticed in Co. 213. Co. 210 showed far fewer cases than Co. 213 of the first two diseases, while Co. 214 was practically free. If it were not for its crooked habit, and comparatively lower tonnage, Co. 214 would be an excellent growers' cane as it is hardy and highly resistant to disease. So far the only trouble observed in this cane has been the top shoot borer, but as this pest appears late in the season, while the cane being an early ripener should be off the ground in November, no serious damage will be done to the crop by this borer. Co. 232 has been found to show a greater percentage of attacks both of smut

and the so-called mosaic disease, and as this cane is in addition a poor tillerer, despite its early maturity and other good qualities, I am afraid it is not likely to displace any of the present Coimbatore canes which growers have down. During the current season efforts are being made to keep a strict watch over the crop in the entire district with a view to detect the first appearance of any of these symptoms and their subsequent development. A careful study is being made with a view to check the disease as far as possible. During the year under review, an Assistant from the Sugar Bureau and a Fieldman from the Mycological Section were sent round to advise the growers to rogue out diseased plants and to select only healthy seed-cane for planting. Instructions were also issued to the growers on the smut of sugarcane, and they were advised to search for diseased clumps, pull them out and burn them so as not to spread the disease. In this connection it is just as well to state that very few, if any, canes are immune to all diseases. In spite of practically all known cane diseases existing in Java, the cane industry flourishes there. What is required is that as soon as any disease is detected, it should be properly studied and measures devised for keeping it under control; at the same time, the search for better varieties should continue. There is no reason therefore for any one to be nervous about Co. 213, which up to date is the best of our Coimbatore seedlings, merely because it is showing liability to smut or mosaic: it is a good tonnage cane and with care and skilful treatment on the part of the grower it should continue to do well.

Out of Government funds the testing plots measuring in all one acre were laid down in the Silk House Area and securely fenced in with "Ideal" wire fencing. The following seedlings were under trial against the standard Co. 213 :—

Co. 205 .. Vellai × *Saccharum spontaneum.*
Co. 248 .. P. O. J. 213 × M_2 (a Kaludai Boothan rogue).
Co. 250 .. Karun × M. 5459 (a Striped Mauritius rogue).
Co. 255 .. P. O. J. 213 × Co. 205.
Co. 260 .. Chittan × Co. 206 (An Ashy Mauritius rogue).
Co. 270 .. B. 3747 × Co. 206.

Co. 273 .. P. O. J. 213 × Co. 222 (Vellai × *Saccharum spontaneum*).
Co. 275 .. P. O. J. 213 × Co. 222 (Vellai × *Saccharum spontaneum*).
Co. 278 .. P. O. J. 213 × Mauritius 55.
Co. 280 .. P. O. J. 213 × Purple Mauritius.
Co. 281 .. P. O. J. 213 × Co. 206.
Co. 282 .. P. O. J. 100 × Co. 206.
Co. 286 .. B. 6308 × Katha.
Co. 287 .. B. 6308 × Katha.
Co. 288 .. B. 6308 × Kansar.
Co. 290 .. Co. 221 × D. 74.

Out of these seedlings, Co. 255, 260 and 278 were rejected and the remaining ones carried on for further trial. Co. 205 has been found to do quite well. It is now being grown on an estate scale with a view to arrange for mill tests. It is a hardy, late ripening cane but with a comparatively low purity as its glucose content is high. It would be useful to the mills at a time when the supply of the early canes has ceased, and its value as a cane to be grown on land unsuitable for other canes is undoubted.

Another important line of work recently started consists in the introduction and acclimatization of some of the best seedling canes in other countries of the world. In view of the fact that some of the P.O.J. seedlings which are used as parents in raising Coimbatore seedlings very readily contract mosaic and serve as carriers of the disease, it is hoped that the importation of varieties which are immune to or highly resistant to mosaic, with a view to use them as parents for crossing or to grow them as field crops if found satisfactory, will not be without useful results. Accordingly, Badila or N. G. 15, which is one of the world's finest canes and is reputed to be highly resistant to mosaic, has been imported from Porto Rico during the year under report and is being grown under strict quarantine conditions in conjunction with the Imperial Mycologist and the Imperial Entomologist. It has also been observed in Java and Argentina that the following seedlings are immune to mosaic :—P.O.J. 2714, P.O.J. 2725. I am therefore in correspondence with the Director of the Proefstation,

Pasoeroean, for the importation of a few sets of these seedlings with a view to grow them under observation and see whether they are really immune to mosaic.* I am also in correspondence with Dr. Calvino in Cuba, and it is hoped to obtain through him some sets of S. C. 12(4) for experimental cultivation here.

Out of the mill trial grant of Rs. 5,000 originally taken from Messrs. Begg, Sutherland & Co. and subsequently amalgamated with the grant of the Indian Sugar Producers' Association, 27·98 acres of plant cane were put down in the New Area and 25·74 acres of ratoons in Harpur Jhilli and 2·28 in the New Area. Co. 232 grew better this year but even then it did not show a yield of more than 430 maunds (one maund=82·28 lb.) of stripped cane per acre. It is a good cane of erect habit and also an early ripener. But as mentioned before, its poor tillering habit, high fibre content and its liability to smut and mosaic now rule it out for distribution to growers. Unfortunately, during the year under report, while the cane was supplied to the mill at its optimum condition of ripeness, the mill was not ready to take it, so the cane was put through the rolls some days after it was cut. Hence the results of the mill test were unreliable. The average figures of analysis as supplied by the Manager, Samastipur Sugar Factory, in his letter dated 2nd January, 1925, were as under :—

	Brix	Sucrose	Fibre per cent. on cane	Sucrose per cent. on cane
Co. 232	20·28	15·44	19·27	12·45
Co. 214	19·90	16·12	16·98	11·93
Co. 210	18·86	14·23	17·76	11·72
Bhurli (Hemja) . . .	14·23	10·85	13·44	9·39

The yield of Co. 213 worked out at 600 maunds per acre over the entire area of 15 acres, while the crop of Co. 210 on 10 acres showed an average of 680 maunds per acre. The

* Since writing this, P.O.J. 2714, 2725, 2727 and 2378, have been received and planted. [W.S.]

drop in yield was due to a considerable extent to bad land. It is interesting to compare with these the figures given by some of the actual growers, *viz.*, Mr. C. E. Crane of Peeruckpore who harvested 46·6 tons (1,270 maunds) of Co. 213 per acre (against 17 tons per acre of Hemja), and Babu Bhubaneshwar Prasad Sinha of Birsingpur 1,200 maunds of Co. 213 per acre. From this it will be seen that the yields obtained from the land where the Bureau grows its cane by no means represent the optimum for these canes.

The ratooning experiments showed that Co. 210 is the best ratooner, with 425 maunds of stripped cane per acre. Co. 232 has been found to be a poor ratooner, Co. 214 doing fairly well with 300 maunds per acre, while Co. 213 ratooned on clay soil which is highly retentive of moisture yielded a crop of 373 maunds per acre, but it is not advisable to ratoon this cane if the plant crop shows any signs of attack by one of the diseases mentioned above.

Co. 280 and Co. 275 were planted out this year under estate conditions for further trial and examination.

The total produce during the year from both plant and ratoon crops grown from funds supplied by the Indian Sugar Producers' Association was some 28,000 maunds of stripped cane, of which about 17,500 maunds went to the Samastipur Sugar Factory for crushing and distribution as seed-cane, about 9,500 maunds were distributed as seed direct by the Bureau on behalf of the Indian Sugar Producers' Association to the growers and about 1,000 maunds used in our own planting for season 1925-26.

There was a brisk demand for the improved canes even from small growers. During the 1925 planting season over a lakh maunds seed-cane of Coimbatore varieties has been distributed from Pusa, Ryam, Dowlatpore and other centres to new growers in the districts. These canes were also supplied in small lots to the—

(1) Agricultural Officer, Peshawar, N. W. F. Province;
(2) Agricultural Institute, Allahabad;
(3) Assam Sugar Estates, Nalbari;

(4) Superintendent, Cinchona Plantations, Mergui, Burma;
(5) Deputy Director of Agriculture, Gujarat, Bombay Presidency;

and in foreign countries to—

(1) The Director de la Estacion Experimental Y escuela Agricola "Chaparra," Oriente, Cuba;
(2) The Director of Agricultural Instructions, Buenos Aires, Argentina;
(3) The Director, Insular Experiment Station, Rio Piedras, Porto Rico;
(4) Assistant Director, Proefstation voor de Java-Suikerindustrie, Pasoeroean.

As regards manurial trials, castor-cake was used as the general manure, but nitrate of soda and ammonium sulphate were also tried on weak patches and were found to be good dressings for forcing up the crop. The use of $(NH_4)_2SO_4$ is spreading among large growers in Bihar, while $NaNO_3$ is being specially recommended for application to the crop intended for use as seed-cane. The system of short planting for multiplying up seed evolved by the Bureau, and the use of improved implements for planting and intercultivation recommended by the Bureau are making satisfactory headway among the growers.

During the year under report, experiments have been laid down to test the value of planting cane at different times of the year. In Bihar cane is usually planted in February, and when the canes have germinated the hot weather comes on and the cane has to struggle hard to keep itself alive as no irrigation is given. Rains break in the latter half of June, and the cane has hardly 4 to 5 months for growth before the cold weather sets in. If therefore cane could be planted at the end of the rains, *i.e.*, in October, there will always be sufficient moisture in the soil, germination would be far more rapid and the crop would be established before the severe cold sets in and be able to start rapid growth directly the temperature conditions permit. The cane would be well down before the hot weather comes on and then will have another period during the rains for vigorous growth. Further, it will

then be possible to grow cane not only on the heavier soils which are very retentive of moisture, but also on light lands which under the present system frequently lack sufficient moisture for germination in February and March after a short monsoon. The experiments so far show that cane planted in October on light lands is far ahead of that planted in February.

As one of the chief expenses in growing Coimbatore canes is the high seed-rate due to the long internodes of the cane, experiments have been laid down to find out the most economical seed-rate, the best way to place the sets in the row to ensure a regular even stand without gaps, and the optimum distance between one row and another.

It is now becoming evident that the general cultivation of cane in the district is improving and that the methods introduced first among the large growers are now working down into district practice, a proof that this is the surest way of introducing an improvement. For, whatever the big man can do with deep ploughing and improved implements over a large area, the small cultivator can do with the *kodali* (local hand hoe) over his few *cottahs* (a *cottah* measures roughly 200 sq. yards). All that is required is that he shall first see someone else making a success of it. He naturally objects to taking the risk of anything new himself with his limited capital until he has seen his neighbours make a success of the new crop.

It may also be mentioned that the Government of Bihar and Orissa, being convinced of the great value of these canes in North Bihar, have sanctioned the appointment of four Fieldmen and Kamdars from the 1st of January, 1925, for propaganda work in connection with the growing and distribution of these canes and placed them under me for training. After a thorough training in the cane work, they are being employed in demonstration work in the districts and keeping the cane crops therein under observation.

II. Industrial.

The Bureau maintained the same relations as in previous years with the factories in India, and its advice was sought

by a number of recently registered joint-stoc companies who were making arrangements for putting up factories in India. The returns for the working season of 1923-24 both from factories and refineries were duly received, and a consolidated statement for the whole of India showing the production of sugar direct from cane and from the refining of *gur* was prepared and published in the "Indian Trade Journal" and the "Agricultural Journal of India."

During the year under review the Belapur Sugar Factory began working in the Ahmednagar District of the Bombay Presidency. Against this, one factory and one refinery, *viz.*, the Assam Sugar Estates and Factories and (2) the Cossipore Sugar Works have stopped working. Some other joint-stock companies for the manufacture of sugar which had come into existence in recent years were also dissolved but none of them had even come to the stage of putting up a factory.

The year 1924-25 was a bad one for the industry. In consequence of the failure of the previous monsoon, there was deficient moisture at sowing time, and hence less area was put under cane. The United Provinces which usually have more than 50 per cent. of the total area under cane in India showed a fall in acreage from 1,554,000 in 1923-24 to 1,300,000 in 1924-25. The factories did not therefore obtain adequate supplies of cane. The prices of sugar as a consequence of the world's increased production of this commodity were considerably lower than in previous seasons, while the high prices of *gur* (raw, unrefined sugar) ruling throughout the year as the result of decreased production in India made it quite impossible for the refineries to work at a profit. The net imports of foreign sugar rose from 375,720 tons in 1923-24 to 648,975 tons in 1924-25.* The great importance of the work being done on the introduction of improved varieties and better methods of cultivation and manuring will now be more clearly realized by the factories as, with the over-production of sugar in Cuba and Java and the restoration of the European beet sugar industry, prices have come nearly to the pre-war level and

* The year here taken is the official year beginning on 1st April and ending on 31st March following.

profits are measured not in rupees but in annas. Efficiency in the field, efficiency in the factory and efficiency all round in organization, this and this alone will enable the sugar industry in India to stand in competition against imported sugar. The Government by fixing a specific duty of Rs. 4-8-0 per cwt. on imported white sugar have given indirect protection to the local industry, but this alone will not solve the problem. The factories must take more and more interest in the ryots growing the cane which the factory crushes, and should assist the Agricultural Department in its efforts to popularize improved varieties and distribution of oil-cake and other nitrogenous manures.

The Bureau continued to assist factories by bringing to their notice the names of suitable persons seeking employment in different branches of this industry. This line of work is appreciated by both parties, *viz.*, the factories and the trained men seeking employment. Most of the factories in this part of India, in improving their milling plant, have made considerable additions and alterations and have also begun to entertain on their staffs qualified Chemical Assistants. With the advent of the improved Coimbatore canes, it is hoped that the factories will not find it difficult to obtain an adequate supply of raw material, as no improvement in efficiency in other departments of the factory will be of any avail if, in the busy season, the factory works one day and stops on another for want of cane.

III. Commercial and Statistical.

The Bureau continued to obtain the price quotations for various qualities of *gur* from a number of important markets in various provinces of India, and these were regularly sent for publication in the "Indian Trade Journal." Statistics as regards stocks of sugar in the markets of the principal ports in India, and price quotations for superior white sugar in Java were also supplied once a week to the Director-General, Commercial Intelligence, for publication.

This office also furnished a note regarding the condition of the cane crop and estimates of sugar production in the im-

portant cane-producing countries of the world for incorporation in each of the three all-India sugarcane forecasts issued by that department.

Notes giving statistical information regarding production, consumption, exports, stocks, etc., in the more important countries of the world were regularly published in the "Indian Trade Journal." The number of such notes supplied during the year amounted to 40.

The Bureau continued to conduct the Sugar Cable Service on a self-supporting basis as heretofore, and it is gratifying to note that it was greatly appreciated by those who subscribe for it. It serves a very useful purpose in keeping sugar merchants and manufacturers fully posted with up-to-date market conditions and fluctuations in prices occurring in the world's sugar markets. It is also of great advantage to smaller merchants who have no sources of market intelligence outside India and who were hitherto handicapped on this account in their business. It also helps to reduce fluctuations in prices to some extent, and this benefits consumers, as the members subscribing for the Cable Service can form a very shrewd guess as to the future trend of prices.

IV. Miscellaneous.

Library. During the year under report, 309 volumes were added to the library either by way of purchase, exchange or free supply, and by binding loose copies of periodicals received in the library. The library is open to all interested in the subject of cane cultivation and sugar manufacture. It is gratifying to note that Government officers as well as the public have begun to take advantage of this library. It is probably the best library on sugar in India.

Museum. During the year under report fresh samples of sugar manufactured by factories and refineries in India were obtained and these have been exhibited in the museum. No samples from foreign countries were received during the year.

Publications. Besides the 40 notes published in the "Indian Trade Journal," a review of the sugar trade in India for

the year 1923-24 was published by me as a supplement to the "Indian Trade Journal," dated 1st January, 1925. Three notes were also published in the "Agricultural Journal of India."

V. Conclusion.

During the four years 1921-22—1924-25, the Sugar Bureau selected and grew on a field scale three Coimbatore seedlings 210, 213 and 214, tested them in the mill to ascertain how they behaved in the factory, distributed over 60,000* maunds of seed-cane, established these varieties in North Bihar with the result that over 5,000 acres are already under these canes in the white sugar tract, has shown factories that it is possible to prolong their period of working from 1st November to 15th April, has shown growers that it is perfectly within their power to double their yield of cane per acre by growing the approved Coimbatore canes instead of the local Hemja, and has put heart into growers and producers at a time when, with the fall in the price of sugar, the inevitable reduction in the price of cane would have made them give up cane cultivation, had it not been for the increased tonnage offsetting the drop in price.

* Grown from funds supplied by private bodies who got their capital returned to them in the shape of cane supplied.

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